MICROCOMPUTING

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Mastering the IEEE 488.

P. 22

ITS 41-1

Your H8 Goes 2400 Baud and 64K PP 81 and 90

Questions REST ROOM FAUTE ABOUT Memory.

A/D for the 80. Easy-to-Build Converter. P. 206

Commodore Goodies Reviewed.

New Computer, Floppies, Software. P. 36

50

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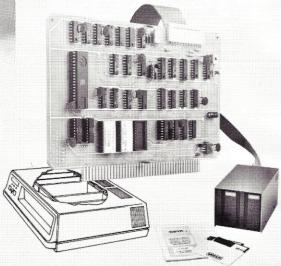
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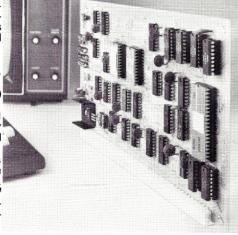
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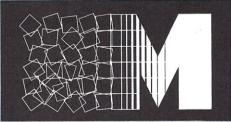
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MICROCOMPUTING*** contents: july '80

ARTICLES

- Get Your PET on the IEEE 488 Bus First of three parts. Gregory Yob
- New Additions to the Commodore Line Computer, floppies, software. Robert W. Baker
- File Sorting Program and Its Diary Part 2 (conclusion). Al Prentice
- Elf Meets a New Friend An SWTP 6800 memory board. Gregory Harris
- The Future Office You may find it in the home. Jeff Noynaert
- Open Up the SWTP 6800 Maximize the system's capabilities. Dr. Gordon W. Wolfe
- The New CP/M: Is It Worth It? This reviewer thinks so. Richard Fritzson
- 68 Dial-up Directory Communications software and the OSI C1P. Frank J. Derfler, Jr.
- 72 TRS Text Formatter Law and Mitchell's text formatter modified. L. H. Daniels
- 81 Heath's H8 Cassette Interface Times Two Double transfer speed. Ronald Baker
- 84 PET Pen Add a light pen to the "PET I/O Port Expander." William F. Pytlik
- 90 64K Memory for the H8 It's a single card dynamic RAM. Myron J. Seibold
- A Use for Misprogrammed PROMs Don't throw away bad 8223s. George Young 98
- 100 The SWTP Computer System A look at 6809 systems. Peter A. Stark
- 112 Electricbill Do your bit to save energy. Brian S. Klinger
- Superboard II: A Second Look What's happened in a year? Rich Jensen 116
- 120 SORTIT: A Sort Program Enhancement to two previous programs. Forest E. Myers
- 126 Line Editor for Benton Harbor BASIC Provides line editing. James F. Teixeira
- 134 \$ Calculating Interest Rates North Star interest calculations. John A. Bryant
- 136 Add Handshaking to Apple's High-Speed Interface A unique mod. Jeffrey G. Mazur
- 140 Predict Variable Trends Interpolation by microcomputer. Blazimir P. Mise
- Use Your Exidy as a Smart Terminal "Talk" to maxi-computers. Ernest E. Bergmann 142
- 148 Hexadecimal Front Panel for Z-80 Systems Construction project. John D. Ciana
- 158 The Sol Also Sets Even if your micro's eclipsed, brighten up. B. R. Evans
- 160 Reader-Service Reply A record-keeping system. Howard J. Siegel
- 164 Questions and Answers on Memory Devices Series continues. David Price
- 172 Cost-Effective Hard Copy for the Apple II With three devices. Allan Turoff
- 174 Matrix Sorting Technique for multiple data sorts. Ross A. Wirth
- Disk Divinations Build a small mini-floppy tester. William Hosking
- 182 Colorful Baud-Rate Generator Uses a TV color-burst crystal. Ken Barbier
- Beat the MIKBUG Memory Squeeze Just flip a switch. Bill Vodall
- X-Y Plotting with an X-T Plotter Use a cheapo chart recorder. Kenneth Reid 186
- Patching the SSB Assembler Make a "super assembler." John L. Alford
- 196 Disassembler for the 1802 More efficient than coding sheets. John Beringer
- A/D Converter Design For the TRS-80 Level II. Arthur Mullin, Jr.

DEPARTMENTS

Publisher's Remarks - 6 Output from Instant Software, Inc. - 6 PET-pourri - 7 Book Reviews - 9 New Software - 11

New Products - 14 Letters to the Editor - 18 Micro-Scope - 208 Dealer Directory - 210 Calendar, Classifieds - 211

Cover: Photo by Tedd Cluff. Bus compliments of Cheshire Transportation Co., Keene, NH.

micro info

This symbol next to a title in the table of contents indicates that the article is a businessapplication article.

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DUBLISHER'S REMARKS

Watch Out—Here Comes Atari!

The lack of extensive advertising in the microcomputer media by Atari has tended to make this company invisible to many computer stores and even to many computerists. The system appears game-oriented, and comes from a game company. Even the name of the product, Atari Personal Computer Systems, works against it. "Personal computer" gives many people the impression that it must be something like a personal calculator. Obviously something "personal" has little to do with such serious subjects as business or education.

Yet, increasingly I see the Atari systems in department stores and electronics stores. One electronics store owner said he found Atari the most cooperative of the major microcomputer firms; he was quickly set up with a demonstrator and some stock. This happened while other manufacturers were still horsing around with credit applications and minimum order requirements.

The April 28 issue of Newsweek must have come as an eye-opener to many in the microcomputer business. There, was a four-page, front-cover, color foldout ad for the Atari systems! This sort of advertising support should help Atari develop its dealer network, enabling Atari to compete with Tandy's 7500 stores . . . a formidable marketing system.

On my recent trip to Europe I found it was more the exception than the rule not to find a microcomputer section in the major department stores. The micros are right in there with the typewriters and calculators-and selling well. Department stores don't invest in merchandise that just sits around. It has to sell or they can't afford the space and the inventory costs. In the case of computers, it also has to sell with a minimum of salesman time since there is no practical way for the larger stores to get trained computer help.

Atari's cartridge form of program transfer may be expensive for consumers, but it is simple to use and makes the Atari virtually selfdemonstrating in stores. How much of a dent Atari will make in the microcomputer market remains to be seen.

The Texas Instruments Approach

While many computerists were disappointed with the TI-99 and felt that it probably would be withdrawn from competition, TI is pushing it, and the 99 is appearing in more consumer outlets. What did I see in Harrod's, the largest and most prestigious department store in England? The TI-99!

In the "Atari" issue of Newsweek, TI ran a two-page ad (pp. 30-31) for the 99 system. It's called a home computer, another term I feel is self-limiting for sales. I wish firms would remember that they are selling computerssmall computers, to be sure, but they are computers. I prefer the term "microcomputers" since it doesn't limit the uses of the equipment in the imaginations of the prospective customers.

The TI ad, like Atari's, says virtually nothing about business use of the system. TI stresses the use of it at home for entertainment, education and finance. It compounds the "toy" concept by stressing the speech synthesizer, which allows the system to talk. TI also mentions that Milton Bradley-a name synonymous with toys—supplies the programs. The four-color "grabber" page picture, showing a group of people all beaming at you from behind a TI-99, and each holding some prop to indicate his interest, is similar to the old Imsai ads

Other Ad Approaches

The best consumer ads I've seen have been those by Apple. They are attention-getting, and they must be prompting sales. I see the same ads running repeatedly in many of the better consumer magazines.

When I look at the Instant Software sales records I see that the top sellers are utilities and educational/game programs. It's something to think about when you put together ads for the general public.

Sherry Smythe

PUT FROM

Report from Europe

The growth of the European market for microcomputer software makes clear the need for a plant to produce Instant Software in Europe. Talks with firms in the field hinted that our best bet would probably be in England or Ireland. Recent construction of plants for Centronics and Memorex in Ireland suggested we check

Ireland has benefits that other countries don't. The Irish want new industry enough to foot part of the bill for setting up a new plant. They will pay the total cost for training their people to work in these plants. In addition to those incentives, they offer a ten-year holiday on taxes-plus another ten years of very low taxes on profits after that. Wayne and I went to Ireland to visit the Industrial Development Authority (IDA) and look at some plant sites, one in Dundalk, near Northern Island.

From Ireland we went briefly to London, and then on to Germany and the incredible Hannover Fair. This huge fair attracts over 500,000, and most of the microcomputer firms, including Instant Software, exhibit there. We got a first look at the new IBM personal computer.

We also visited computer stores and Tandy stores. In many, people had the idea that American business programs would not translate well for European use because the business systems were different. We looked into that possible problem and found that only some of the accounting systems were different. Most businesses encounter the same programming needs, no matter what the country. The big need in Europe is for business-applications pro-

While visiting a Tandy store in Rotterdam, Holland, we located someone to do the Dutch translations of Instant Software programs. In Amstelveen, Holland, we viewed the Hong Kong-built TRZ-80 system, which operates on TRS-80 software and comes complete with Microsoft BASIC.

When we went to Belgium, we found a smalltown Tandy store selling three TRS-80 systems a month. Microcomputers are gaining steam in Europe. We were surprised at the penetration of TI; we saw TI systems on sale in London, Germany and France.

Tandy is limited by the number of their stores, but they are developing Tandy Computer Stores, with, I think, four in place so far. We stopped at one in Köln that was selling about 25 systems a month. Not bad!

I-POUR

A Multiprocessor Printer

XYMEC, a subsidiary of Litronic Industries, recently announced a revolutionary "intelligent" printer, for personal and small-business computer applications, that will interface to the PET.

The HY-Q 1000 is a low-cost, letter-quality daisy-wheel printer with five internal microprocessors. Simple "control" codes provide many commonly used text formatting functions and eliminate the need for complex, memory-consuming software packages. The average throughput print speed is 30 characters per second, and the printer has a full function keyboard.

The HY-Q 1000 provides "Quadra-Pitch" with 10, 12 or 15 characters per inch and up to 198 characters per line. It also has proportional spacing and prints 100 printable characters in five languages without changing the daisy wheel. Another unique feature is its reverse printing, with white characters on a black background. You can even choose from 21 type styles and five ribbon colors.

Other interesting features include underlining and bold printing, right justification, decimal point location, title centering, auto column layout mode, auto printing of vertical lines to separate columns, auto (paragraph) indent mode, full electronic tab functions and auto storage/recall of often-used phrases and formats.

The printer retails for \$2495 and is based on an Olivetti electronic typewriter. It comes with a three-month warranty, and maintenance is readily available at over 500 Olivetti service centers throughout the United States.

For more information, contact XYMEC, 17791 Skypark Circle, Suite H, Irvine, CA 92714.

Quick Reference Card

The price of the PET Quick Reference Card was listed incorrectly in the December column. The correct price is \$3.50, postpaid, from Leading Edge Computer Products, 4471 Santa Monica Blvd., Los Angeles, CA 90029.

The reference card has nine pages of condensed notes and information on the PET folded to a handy pocket size. It covers the operators, special variables, monitor commands, BASIC commands and statements, ASCII character values, I/O device addresses and status bits, functions, abbreviations and useful memory locations for all models. A second printing is planned, and should have more information on the PET printer and disk.

I hope Leading Edge considers adding the BASIC token values that are not in the current version, since I use these quite a bit. Otherwise, the reference card is fairly complete and contains nearly everything you would ever want.

Spacemaker Update

The new PETs and CBMs provide three sockets on the primary logic board for ROM expansion. They are addressed as 4K blocks with a starting address of \$B000 (hex). Several ROM-based products use the same address space and therefore cause a conflict if more than one is desired. Specifically, the Commodore Word Processing Package, the BASIC Programmer's Toolkit and the Computhink DOS all use the first available expansion socket.

In my last column I mentioned Small System Services. SSS's Spacemaker is a utility device for new PETs that is designed to allow user selection between ROMs that must occupy the same address space. The companion ROMdriver and user I/O packages allow simple software selection of various groups of ROMs installed in one or more Spacemakers.

I recently received a sample Spacemaker along with more complete documentation. The unit impressed me. The documentation and hardware are both excellent.

The Spacemaker board is only 4.25×2.25 inches and plugs vertically, by a special header, into any of the ROM expansion sockets inside the new PETs. A pair of conflicting address ROMs are then inserted in the two 24-pin IC sockets on the Spacemaker board, and the installation is complete.

The board also has a short cable attached to a miniature toggle switch that mounts conveniently on the outside of the PET. The switch is actually mounted using a pressure-sensitive mounting clip, so no drilling or modifications are required. This switch provides manual selection of either of the two ROMs mounted in a single Spacemaker. Since Spacemakers were designed to work alone or in tandem, additional units can be added to switch pairs or groups of ROMs if necessary.

For even greater flexibility, an extra connector on the Spacemaker board provides an interface for software control of ROM switching. This normally requires either the user I/O kit or the ROMdriver controller board. The user I/O kit includes a simple user port connector and a utility program provided on diskette. If your user port is already dedicated or used frequently, the ROMdriver controller board provides identical functions without using the user

MICROCOMPUTING T.M.

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A single installed ROMdriver or user I/O package can serve as the resident controller for one, two or three Spacemakers, with ROM selection and switching via software. But whenever more than one Spacemaker is used, additional cables are required and are optionally available.

SPACECTL, the utility program provided, maintains a user ROM menu and displays a list of the available utility software as defined by the user. It will show which items use a particular ROM and whether that ROM is enabled. disabled or under manual control. When you select a utility, SPACECTL will enable the selected software and set ROMdriver to enable or disable the necessary ROMs. SPACECTL can be easily adapted for different configurations, more Spacemakers and new or different utilities by simply modifying the menu table itself.

A Computhink option is also available for the new Computhink disk drives, with DOS in masked ROM only. Since Computhink already uses the PET user port for printer output, both the Spacemaker and ROMdriver are suggested. But only one Spacemaker can be used.

For detailed pricing, availability and more information on options and configurations, contact your local PET dealer or write Small Systems Services, Inc., PO Box 5119, Greensboro, NC 27403.

Programming Ideas and Tips

Here's another interesting subroutine from the old 8K ROM operating system. This one will search the BASIC program variable table looking for a specific variable and return a pointer to the variable. By reserving certain variables for specific purposes, you can easily pass multiple parameters between machine-language routines or user functions and the main BASIC program. This can be much simpler than peeking and poking values into fixed memory locations, since you may have to convert values before using them. By using standard BASIC variables to pass parameters, the values are always in the correct form and ready to use.

To use this subroutine, you must first understand how the variables are stored in memory by BASIC. All simple variables or variable pointers are stored as 7-byte values in the variable table. Disregarding arrays, the first two bytes of each entry identify the two-character variable name and the variable type as either integer, floating point or string (see Table 1).

The remaining five bytes will either contain the value of the variable or a size and address pointer to the string (see Table 2).

For more information, see the section on variable allocation at the back of your PET user manual. If you have a new ROM set or a 16/32K PET, then the format shown in the manual for arrays is incorrect, since the limit of 255 array elements was corrected.

Now back to using the subroutine to find a given BASIC variable. Before the subroutine can be called, you must set the variable you are searching for in locations \$94 and \$95 (148 and

149 decimal). This corresponds to the first two bytes of each 7-byte entry in the variable table (Table 2) with the flag bits to indicate the variable type

You then call the subroutine at location \$CFDB (53211 decimal). On return, locations \$96 and \$97 (150 and 151 decimal) will contain the address of the first byte following the 2-byte variable name in the variable table. Thus, this address can be used to directly set the value of a floating-point or integer variable or to get the length and starting address of a string.

One word of caution on using this routine. The variable should be defined somewhere in the BASIC program prior to being searched for by this routine. If not found, the variable will be added to the variable table with a default zero or null string value.

For those who have the new ROMs or new PETs, I'm sorry I haven't had time to track this routine down in the new ROMs. If someone is able to locate it, please let me know.

Programming Style

Over the past year or so, I've helped Instant Software with their reviews of several programs written for the PET. One of the biggest problems I've seen with the software submitted is the lack of checking for valid responses to ques-

It usually doesn't take much added effort to have the program check all user input. It can be very frustrating to a user if the program stops because he typed in a bad value or accidentally hit the wrong key.

You should always use a string variable for user response and convert strings to numbers when required, using the VAL function. This allows you to check for valid responses in all cases before trying to use a value. It also prevents the confusing REDO FROM START error message if you enter a letter when the program expects a number.

If only a single character response is required, use the GET function to eliminate the return required by an input:

100 GET R\$: IF R\$ = "" THEN 100

This also eliminates the problem of stopping the program if the return key is hit without en-

Variable type	Byte-1	Byte-2
Integer	char1 + 128	char2 + 128
Floating Pt	char1	char2
String	char1	char2 + 128

Note: If the variable is a single character name, char2 will have a zero value.

Table 1.

٧	ariable type	Byte-1	Byte-2	Byte-3	Byte-4	Byte-5
	Integer	256*HI	LO	0	0	0
	Floating Pt	[actual	floating	point value]	
	String	#chars	ptr-HI	ptr-LO	0	0

Table 2.

tering any data in response to an input. This latter problem can also be avoided by printing a default response before asking for input. The best method I've seen involves printing the normal question with three additional spaces and the half-box character () generated by the shift quote key. Then print three cursor lefts to replace the cursor to the normal position after the question and ask for input. The cursor will appear as a half box alternating from top to bottom and back. If the return key is not hit without entering any other data, you'll receive the half-box character as a default input and can substitute another value if desired:

```
100 PRINT"FILE NAME [3-spaces] ■ [3-c1]";
110 INPUT N$
120 IF N$ = "■" THEN N$ = "DEFAULT"
```

You could also use this method to set up a real default answer such as Y or N, then simply hit the return key to use the preset default value:

100 INPUT"PRINTED COPY [3-spaces] N [3-c1]";A\$

When using the GET command, a simple subroutine will accept any one of a predetermined set of valid responses. By setting a variable to contain a string of valid characters before calling the common subroutine, the subroutine will then accept only valid characters before returning:

```
100 R$ = "NSEWUD" : GOSUB 5000
240 R$ = "YN" : GOSUB 5000
590 R$ = "12345" : GOSUB 5000
5000 GET C$: IF C$ = "" THEN 5000
5010 \text{ FOR } X = 1 \text{ TO LEN(R\$)}
5020 IF C$ = MID$(R$,X,1) THEN RETURN
5030 NEXT: GOTO 5000
```

This subroutine will only accept characters defined in R\$ prior to returning.

One other problem I saw was in a menudriven program. The program displayed a list of options and asked the user to enter the number of the option desired. In this particular program, one option had to be used prior to selecting certain other options to set up specific

The problem was that there were no checks that the proper sequence had been followed; the program could generate erroneous results when the improper sequence was used. A simple solution would have been to add a variable as a flag that set to a nonzero value when the required sequence was executed. The flag could then be tested before trying to do a particular operation that depended on prior data being established.

When you write a program for others to use, you should be extremely careful with the user interface. Remember, you wrote the program and should know what it's doing. The user is completely ignorant as to what is being done inside the program and cannot be expected to know what you are expecting him to do.

Try to make the program as idiot-proof as possible, even if it seems silly. Don't let the user do anything you don't want him to do. Then, before submitting a program to any organization for review, have someone who knows nothing about the program try it.

Recent Letters

In the January issue, I gave information on how to use a Block Move routine in the 8K BA-SIC ROM. At that time I did not have the new ROMs and did not have the corresponding information. Mike Munchy of Brooklyn, NY, found the routine in the new ROMs and sent the information in Table 3.

For more information on this routine, see January's PET-pourri.

Several people commented that they didn't see a need for the BASIC line number search routine. Think about this one: how about storing small amounts of data within DATA statements to eliminate tape data files? . . . how about deleting game instructions printed by a subroutine at the end of a program and replacing the entire subroutine with a simple

OLD ROM . . . NEW ROM . . . FUNCTION

\$A9-\$AA \$57-\$58 upper limit-old area to be moved \$AE-\$AF \$5C-\$5D lower limit-old area to be moved \$A7-\$A8 \$55-\$56 upper limit-new area to move into

\$C2DF routine starting address

Note: all values are shown in hexadecimal.

Table 3.

RETURN command? You'll need to know where the BASIC lines are located in memory,

Anyway, think about it. I'm confident someone out there will discover a good use for the routine. If you come across any new ROM routines you think may be useful, drop me a line and we'll spread the good word.

Another letter came in from Preston Marshall of Walpole, MA, explaining the Axiom printer direct speaker control along with a sample program. A CHR\$(6) turns the speaker on by energizing the speaker electromagnet. A CHR\$(5) will then turn the speaker off. After locking the printer on the IEEE bus with a CMD instruction, putting a delay between the two speaker control characters and repeating the action for a period of time will produce various sounds.

Because of the execution time of BASIC, you cannot get any high-pitched tones from the printer speaker. It can't compete with the quality of sound produced by the normal PET sound interface (the user port CB2 line), but it might be useful for some purpose.

Anyone with an Axiom printer who's interested can try the following program to see what the printer speaker will do:

100 INPUT "ENTER TIME DELAY (1-300)"; M 110 OPEN 4,4 : CMD 4 120 FOR I = 1 TO 1000 130 PRINT CHR\$(6); 140 FOR K = 1 TO TM : NEXT K 150 PRINT CHR\$(5); 160 NEXT I 170 PRINT#4 180 CLOSE 4

Please do not send PET-pourri correspondence to Microcomputing. We have to turn around and forward it to the author, which wastes time and postage. If you want to correspond with Bob Baker, please write directly to him at 15 Windsor Drive, Atco, NJ 08004. Thank you.

OK REVIEWS

Learning Level II

David A. Lien Compusoft Publishing, Inc. San Diego, CA, 1979 Softcover, 352 pp., \$15.95

In 25 chapters and four appendices, author Lien and editor Dave Gunzel have combined talents once more to produce another important installment in their Everyman's series of microcomputer programming instruction books.

Chapter 5, "Chasing the Errors," and Appendix A, "Level II Error Message Reference Guide," are particularly valuable.

Chapter 5 takes much of the mystery out of error trapping by explaining how to use ON ERROR GO TO, ERL and ERR/2+1 state-

In Appendix A, Lien explains the 23 error codes to which the TRS-80 Model I responds. More significantly, he provides a series of test programs that demonstrates how each error is generated and corrected.

The book also lists changes that can be made with pen and ink in the User's Manual for Level I to make that book-another Lien/Gunzel work-compatible with Level II BASIC.

A second section can be removed from the book, cut into parts and pasted into the Level I

Chapter 1, "Level II Overview," got my attention immediately by explaining how hardto-find syntax errors can be created unwittingly by use of a variable name that includes one or more of the 118 reserved words used in Level II BASIC and disk BASIC. Even using simple, two-letter variables such as ON, TO, IF and OR can cause syntax errors.

In the two chapters that explain how to use the Level II editor, I learned that the editor is not part of the BASIC interpreter. It is a special feature that is called using the word EDIT.

I learned also that while in the edit mode, I could type L after each insertion, deletion and so on (before pressing ENTER) to view the current condition of the line being edited. Somehow, I had missed that subtle point in the Level II BASIC Reference Manual.

Other chapters in Lien's book for nonprofessional users of Level II BASIC deal with searching and sorting routines, special uses of the INKEY\$ function, applying PRINT US-ING statements to control both numbers and strings and using PEEK and POKE.

Lien presents sample programs to demonstrate the use of commands, statements and functions. He introduces errors into each program to highlight the inherent limitations of the BASIC interpreter; however, he always follows the mistake with a correction.

Also included in the book are chapters that teach TRS-80 Model I owners how to convert programs from Level I BASIC to Level II BA-SIC, use the Radio Shack expansion interface, operate the real-time clock that comes with the interface unit and operate dual cassette record-

As he did in the User's Manual for Level I, Dr. Lien, an uncommonly gifted educator, employs a light, folksy style to disarm his readers and make them more receptive. He makes learning fun. For example, he introduces DEFSTR (to define specific variables as strings and eliminate the need to append the "\$" to the variable) as a statement to be used by thrill seekers only, claiming that DEFSTR will be loved by those who attract trouble.

In another sample program, he uses string variables containing DATA statements without first clearing memory space (beyond the 50 bytes that are automatically cleared). He then allows the reader to run the program until an out-of-string space error (?OS error) occurs. He proceeds to explain how the error occurred

Learning Level II was an educational experience for me in many ways. Within a month

from the time I had received my copy of this book, I received an errata from the publisher. It contained corrections for typesetting and programming errors that had appeared in the printed book. Never before had I received such consideration from a publisher.

Every owner of a TRS-80 Model I system should own and use a copy. It will prove useful as both an instruction manual and a reference book. And-unlike the Level II BASIC Reference Manual-Learning Level II comes complete with an index.

> Sherman P. Wantz Sebring, FL

PIPS for VIPS, Vols. I and II

Tom Swan Aresco PO Box 1142, Columbia, MD \$19.95 each with tape cassette

VIP owners will find the first two volumes of PIPS invaluable sources of information.

I got Vol. I while wrestling to get a 4K program into 2K. PIPS included a CHIP-8 editor, just what I needed. Instead of a single byte, I can now see five instructions. The editor can also easily relocate blocks of data.

The same volume included a text editor, an 1802 machine-language disassembler, a character designer and two game programs.

The text editor is moderately handy with such functions as scrolling, cursor and insert. It allows six pages, each containing 16 lines of 16 characters.

The disassembler gives assembly-language mnemonics from the machine-language pro-

With the character designer, I can create my own display characters. I've been so busy writing, editing and disassembling programs, I haven't had time to try the games!

Aresco came out with Vol. II a few months later. This time Tom Swan had created something even better than the editor-a CHIP-8 assembler.

The assembler uses the text editor for entry of the source program with labels and comments. It outputs a symbol table, a link table and an object code on tape. These outputs include addresses calculated from the labels in the source code:

Vol. II also included the software modifications needed to use an ASCII keyboard with the text editor.

The loose-leaf books (without binders) are obviously not high-volume productions, but they are well-written, and often more thorough than RCA's VIP manual.

I do have a few criticisms. First, some of the alphanumeric characters used in the text editor are strange. Given the limited display resolution of the VIP, though, it's hard to do better.

Second, PIPS, Vol. II, assumes you just plug in an RCA keyboard.

Third, Aresco sent me the Vol. II tape without any information on the contents. I hope they've corrected this error in later mailings.

Although you can buy the books without the

tapes for \$14.95 each, don't skimp. Without the tapes, you'll spend days punching in the programs. Also, the symbols for display are referenced several times, but given only in Vol.

> Joe Everhart Brooklawn, NJ

TEA: An 8080/8085 Co-Resident Editor/Assembler

Dr. Christopher A. Titus Howard W. Sams & Co., Inc. Indianapolis, IN, 1979 Paperback, 254 pp., \$8.95

If you've ever gone into a computer store and asked for a low-cost assembler, you probably couldn't help notice the salesmen in the back laughing at you.

Let's face it—low-cost assemblers are almost nonexistent. When you do find one, you discover that the \$19.95 assembler requires a \$129.95 text editor.

Fortunately, Dr. Titus has changed all that. TEA: An 8080/8085 Co-Resident Editor/Assembler describes a text editor and assembler program designed to work on 8080 and 8085 microcomputers. The text editor and assembler reside in memory simultaneously, therefore taking a fraction of a second to jump from one program to the other. Hence, creating source programs, assembling them and correcting them becomes simple.

The TEA (Tychon Editor-Assembler) text editor has an impressive number of features and commands. Titus thoroughly explains the commands and gives an example of each. They include APPEND, which allows text to be added to a source program; INSERT, which allows one or more lines of text to be inserted between two others; DELETE, which erases a line; and SEARCH, which will search the entire source program for a specific string.

Other commands save or load the program onto paper or cassette tape, change memory boundaries and call special user-written subroutines. The editor also features an auto-line numberer and several error messages to prevent you from accidentally destroying your program.

The TEA assembler, which converts the source program into machine code, passes over the source program three times.

The first pass generates a symbolic address table, which contains the 16-bit addresses of the various subroutines, jump destinations, buffer locations and so on.

During the second pass, the mnemonic op codes are converted to the binary values that the microprocessor can understand and exe-

Finally, the third pass is used to create a listing of the assembled program containing the op codes and data bytes in either octal or hexadeci-

The assembler features a number of error messages and will specify on which line the error occurred. Pseudo op codes can be used, and labels, statements and comments don't need to be in any rigid format. Thus, a label can be anywhere in a line without an error occurring.

In addition, you can have several independent programs in the memory simultaneously. Should you have a source program that's too big for your memory, you can break it into several subprograms and merge them during the assembly process.

TEA's I/O subroutines will interface CRT terminals, audio cassettes and paper tape readers and punches. Should you find these routines incompatible with your I/O devices, you should be able to modify them. You can also easily add other I/O routines for such things as floppy disks. Once you've added the new subroutine, you simply change two bytes in TEA's jump table and you're done.

The book's appendices include a description of the TEA paper tape format, an explanation of how to modify the Z command, a description of how to add nine user commands and a summary of TEA's 17 commands.

The assembly listing (Appendix E) contains memory addresses, op codes and mnemonic codes and is lavishly commented. In fact, by carefully studying the comments, you should easily be able to modify TEA to suit your personal needs.

TEA is a comparatively large program; it resides in slightly over 6K of memory. The minimum recommended configuration is 8K.

As of this writing, no one offers TEA on paper tape, floppy disk or cassette tape. You will therefore have to hand-load TEA into your memory, a tedious and slow process. It took me over 20 hours to relocate and load the program, debug it and modify the I/O routines.

Since TEA is written in 8080 machine code, it will also work on 8085 and Z-80 systems (it will not be able to use Z-80 mnemonics). If you own several different systems, it should be easy to convert TEA into a cross-assembler that generates op codes and mnemonics for other CPUs.

I do have two complaints. First, any instructions in the source program that involve memory references (e.g., JMP, CALL, LXI SP) require three lines. The first line contains the op code, the second contains the operand and the third must contain a Ø. The reason for this is when the assembler prints a listing of the assembled program, it prints one byte per line. Hence, two-byte instructions require two lines, and three-byte instructions require three lines.

The Ø reserves a line for the third byte. If the Ø is left out, an error will occur; this can be a problem for those who have worked on assemblers that use a different format.

Second, I was hoping the book would discuss how assemblers work so I could develop one for my 1802 system. But it is closer to a user's manual than a how-to book.

Nevertheless, if you are interested in how text editors or assemblers are written, I suggest you purchase this book anyhow, since it does have one of the few complete listings of such programs that I have seen anywhere. If you are studious, you should be able to figure out how TEA works by carefully examining the listing and its numerous comments.

> **Steve Dominguez** Golden, CO

NEW SOFTWARE

Music Interpreter

Musicraft is a development system that turns your computer into an easy-to-use interactive musical instrument on which to create, store and perform music. It produces up to four voices, each with a seven-octave range, each with different musical sounds. It supports measures, musical line numbers, repeats, refrains, key signatures, accidentals or microtones. An advanced screen editor features simple notation and automatic error detection. The five integrated machine-language programs are: Setup, Editor, Waveform Generator, Interactive Play and a two-pass Compiler.

Musicraft requires an 8080, 8085 or Z-80 S-100 bus computer with a 24K CP/M system, a terminal with addressable cursor and the Newtech Model 6 Music Board. It is available on 8-inch single-density IBM, single-density North Star and Micropolis Mod II CP/M formats. Price is \$79.95.

Newtech Computer Systems, Inc., 230 Clinton Street, Brooklyn, NY 11201. Reader Service number 483.

Record Selection for MWP Files

SELECT/MWP includes the Select program, which copies selected records from a mini word processing (MWP) name and address file to a new file. The selection criteria are interactively defined by the operator and allow complex selection tasks based on one or more of the variable values in each record. Any number of selection requests may be specified.

System requirements include an 8080 or Z-80 mainframe with 48K of memory, floppy or hard disk and CRT. It operates on CP/M with Microsoft MBASIC or Mits/Pertec Disk Extended BASIC. The MWP system is required for use of Select. Price is \$95.

The Software Store, Ltd., 706 Chippewa Square, Marquette, MI 49855. Reader Service number 492.

Forms-Control Word Processor

DataStar word-processing software is a forms-control-oriented, general-purpose data entry, retrieval and update system specifically designed for office personnel usage. The keyboard input format is designed for high-volume production by clerk typists, and its dynamically displayed menu of operator prompting is

designed for easy learning.

Complete control is provided by visual feedback over forms design, individual field length and recording attributes, data entry order, data verify procedure (selective field verify by field order, by sight, retype or list match), disk record format, as well as arithmetic processing using any combination of field, constant and file-derived numeric data. Completely CP/M compatible, DataStar operates with any CRT terminal or video board possessing addressable cursor and 32K-48K RAM. Data files constructed by DataStar are compatible with any CP/M-MP/M-supported language. Price is \$350.

MicroPro International Corporation, 1299 Fourth Street, San Rafael, CA 94901. Reader Service number 478.

Imagination Business Program

The Personal Business Machine is a new business program for the Imagination Machine from APF Electronics, Inc., 444 Madison Ave., New York, NY 10022. It allows you to calculate financial status and compute loan amortization, interest and principal payments and interest rates. It computes exactly how much you can save by paying off the balance of your loan this month, or it will help you determine how much profit an investment will yield within a certain time period. Reader Service number 490.

North Star Menu Builder

MENUBldr, written in North Star BASIC, permits a user to generate screen menus in 2-3 minutes. Adding additional items or changing the format takes less than a minute. In a tenmenu application program, the user will typically save three to ten hours of development time.

Control information, displayed after every change, is user specified for each menu. The user thus sees the actual menu format without running the application software. Changing an existing menu requires only changing the desired menu control. The program stores the menu control values, menu title and menu text on a disk. Menus can be shared between programs, which is useful for standardizing formats. The companion program, MENU-PRNT, is used with the user's application software display's previously created menus. The application software is appended to MENU-

PRNT. Menus may be displayed on a CRT or printer. MENUBldr requires a 24K RAM system with a disk drive. Price is \$48 for source code on a single- or dual-density disk.

American Planning, 4600 Duke St., Suite 425, Alexandria, VA 22304. Reader Service

Real Estate Program

REILEY, a real estate index and locator, is a system of BASIC programs designed to help real estate agencies find properties for customers. These interactive search and sort programs automatically match the home specifications of a prospective buyer with current Multiple Listing Service (MLS) listings. No complicated codes or symbols are required to access information, nor is computer expertise necessary.

REILEY can give comparisons of mortgage terms, access detailed property descriptions, print complete amortization tables, estimate the monthly payment and sale price that the buyer can afford and determine the replacement price of any home on the MLS file. To operate REILEY, you need a single-drive, singledensity system with 24K of user memory.

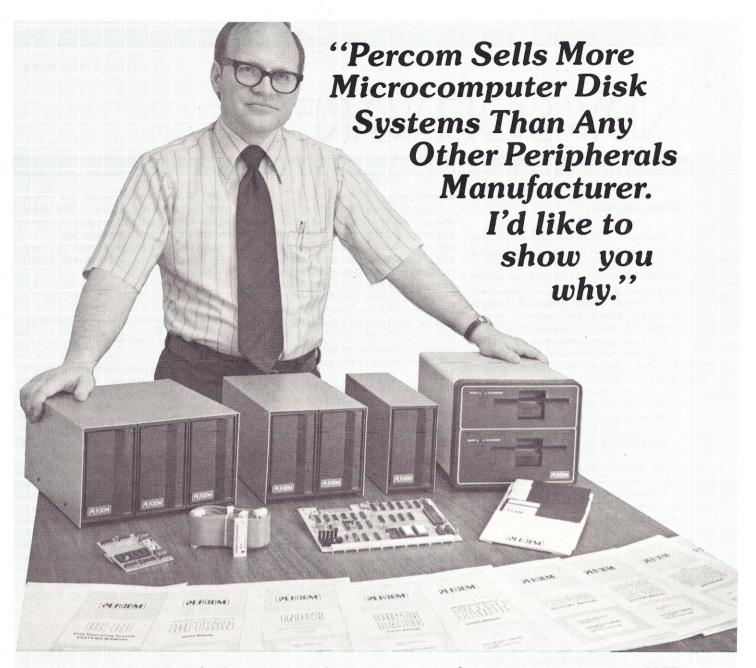
The Electric Abacus, 19 Mayfield Rd., Regina, Saskatchewan S4V 0B7, Canada. Reader Service number 499.

PET Word Processor

Paper-Mate Command 60, a full-featured word processor, incorporates full-screen editing with graphics for all 16K or 32K PETs, printers and disk or tape drives using 60 commands. It also includes most features of the CBM WordPro 3.

For writing text, Paper-Mate has a definable keyboard so you can use either business or graphics machines. Shift-lock on letters only, or use the keyboard shift lock. All keys repeat. Text editing includes floating cursor, scroll up or down, page forward or back and repeating insert and delete keys. Text block handling includes transfer, delete, append, save, load and insert. All formatting commands are embedded in text for complete control. Unlike most word processors, PET graphics as well as text can be used. Paper-Mate can send any ASCII code over any secondary address to any printer. Price is \$29.

A B Computers, 115 E. Stump Road, Montgomeryville, PA 18936. Reader Service number



"Percom has been manufacturing mini-disk storage systems for microcomputers since 1977 when we introduced the 35-track, single-drive LFD-400[™]. Now we produce 1-, 2- and 3-drive systems in 40- and 77-track versions, a multi-density MEGABASE™ system and a host of accessories and software.

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TM trademark of Percom Data Company, Inc. *trademark of Tando *trademark of Tandy Radio Shack Corporation which has no relationship to Percom Data Company. "From an efficient 1K-byte control system DOS to high level languages such as FORTRAN



"Connie is running a 'cats eye' test on a mini-disk drive to check radial track alignment. Drive motorspeed timing and sensor alignment tests have already been performed. Disk formatting and format

verification tests are next. These measurements are part of the 100% testing every single unit receives."

"Whether you call about a shipping date or ask a tough technical question, you get a competent courteous answer. Outstanding customer service is a hallmark of Percom."





"Slipping a circuit board through the eye of a needle would be easier than slipping a cold solder joint past Beverly. These are four-drive LFD-400/800 disk system controllers she's inspecting.

PET Printer Interface

The TNW-1000 is an IEEE-488 bus serial interface for the Commodore PET/CBM. It provides an output-only serial port to interface to current-loop as well as standard RS-232 printers and other devices. It is designed to mount right to the back of the PET's cabinet but can be used with other IEEE-488-capable computers. An edgeboard connector is provided to allow daisy chaining of other devices on the IEEE bus with the TNW-1000.

You can select the baud rate from 110 to 9600 and switch-select automatic conversion from PET to ASCII character sets for either new- or old-style PETs, data word length and parity (8-bit words without parity or 7-bit words with even or odd parity) and IEEE bus address. Price is \$129.

TNW Corporation, 3351 Hancock St., San Diego, CA 92110. Reader Service number 494.

Receive-Only Serial Printers

The Printerm Model 877 is an 81/2 inch receive-only serial printer from Printer Terminal Communications Corp., 124 Tenth St., Ramona, CA 92065. It achieves high reliability through microprocessor control and low parts

The unit is a bidirectional 9×7 dot matrix printer featuring a heavy gauge, hardened metal chassis and stainless steel drive screw and utilizes a cartridge ribbon to eliminate ribbon reversing mechanisms as well as to assure print quality. It prints 120 characters per second at 80 characters per line, 10 characters per inch, using the ASCII set of 96 characters. The internally contained paper roll is friction fed.

The 877 utilizes a serial EIA RS-232C interface, with asynchronous baud rates from 300 to 9600. Dimensions are $18 \times 22 \times 7.5$ inches and weight is 25 lbs. Price is \$999. Reader Service number 482.

PIA Card

Quality Research Co., PO Box 7202, Spokane, WA 99207, offers a convenient way to design a custom interface or construct a timer, EPROM burner or A/D converter for your SS-50 system. The 80-205 PIA card is a prototyping card designed to fit one 30-pin I/O slot. It is a double-sided, plated-through board with lines etched for a 6820 or 6821 PIA that requires no hard-wiring of all the data and control lines.

The PIA outputs—as well as the following bus lines: reset, R/W, Ø2 clock, all five baud lines, \pm 12 V, ground and the onboard regulated \pm 5 V line—are brought to a user area. The NMI and IRQ lines are jumper selectable for both sides of the PIA.

Although there is no solder masking or component labels on the board, assembly is easy to do. The two pages of instructions contain assembly information, a component layout and schematic.

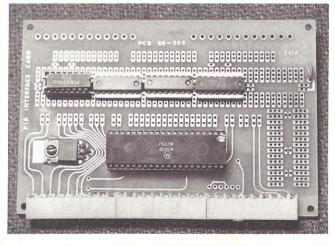
Shipment was prompt. I received my board and optional edge connectors 17 days after sending QRC the order. The 80-205 bareboard is \$8.50, and the bottom edge connectors are \$3, postpaid. Compared with the \$14.95 Percom blank board and the Microworks \$24.95 universal I/O board, the QRC product seems to be a better bargain if you are using a PIA. Reader Service number 475.

> Dennis Doonan Racine, WI 53403

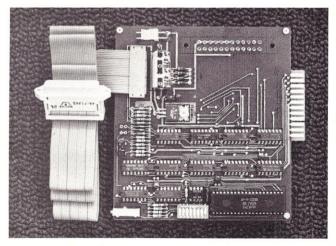
Lowercase Conversion Kit

Now you can have lowercase letters on your Centronics 779 or Radio Shack Line Printer I with the Conversion Kit I from Service Technologies, 3844 Spring St., Box 1426, Nashua, NH 03061. It allows a full 96 ASCII-character set with your choice of a zero with or without the slash.

This easy-to-install modification takes less than five minutes and only requires the use of a screwdriver to take off the back of the printer, remove one IC, plug in a small PC circuit board in its place and connect two jumper wires. There are no traces to cut nor connections to solder that will void your warranty. You can return the printer to its normal uppercase-only status by simply removing the kit and replacing the original IC. Price is \$124.95. Reader Service number 493.



The Quality Research 80-205 PIA card in use.



The TNW-1000 interface board.



Pascal Terminal from ACI.

Pascal Terminal

The ACI Pascal video terminal is an optimized 12-inch CRT (24 lines × 80 characters) for use with the UCSD Pascal operating system or other applications requiring similar video terminal capabilities. It incorporates a separate ETX key along with standard UCSD Pascal X-Y cursor addressing. Home is defined as the upper left-hand corner.

The ACI Pascal Terminal provides a standard upper-lowercase 96 ASCII-character set. It accommodates several international language character displays by internal switch changes (no optional ROM required). Cursor display is switch selectable for either steady or blinking underline or block. The terminal also incorporates provisions to display 32 control characters. Characters are formed in a 5 × 8 pattern within a 7 × 10 dot matrix with descending cursor.

Associated Computer Industries, Inc., 17751 Sky Park East, Suite G, Irvine, CA 92714. Reader Service number 477.

Graphics and Scientific System

The AVTEK 1800 Graphics and Scientific System is a new microcomputer system that includes a 256 × 512 multigraphics terminal, 64K memory, dual 8-inch floppy-disk drives and floating-point processor. Hardware options include double-density drives, an X-Y plotter, a word-processor printer with scientific character wheel and a 132-column printer.

System software includes a screen-oriented editor, a word-processing package (with features for creating scientific papers), a communications package and both subroutine and stand-alone packages for graphics and scientific applications. Programs may be written in FORTRAN or assembler, with other languages available as options. AVTEK's new CP/M-based operating system provides substantial increases in speed and disk-storage

National Computer Communications Corp., 260 West Ave., Stamford, CT 06902. Reader Service number 485.

Apple II Printer

The Silentype thermal printer is an advanced text and graphics printer for the Apple II computer. With this low-cost peripheral you can print on paper copies of anything that the computer can display on a video monitor or television screen. Printing modes, formats and intensities are all variables that are under your control.

As its name suggests, the Silentype is completely silent when printing a line of text or graphics and makes only a slight sound when feeding paper to start a new line. It uses a 7-dot thick-film printing element to produce 5 × 7 dot characters and graphics on standard thermal paper. It prints up to 80 characters per line on 81/2-inch-wide roll-fed paper. Price is \$595.

Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95051. Reader Service number



Cleaning kits for diskette heads to help cut down on system interruptions and losses of data are available from 3M, Dept. DR80-1, Box 33600, St. Paul, MN 55133. Scotch Head



Scotch Head Cleaning Diskettes.

Cleaning Diskettes use a unique wet-and-dry method by which a proprietary cleaning solution is applied to the porous cleaning fabric in the diskette envelope. Then run the cleaning diskette for 30 seconds. Another portion of the diskette wipes the head dry, and the system can be used immediately. You can clean two-sided systems with the same technique.

Each kit contains two diskettes (specify either 8 inch or 51/2 inch) and sufficient solution for 30 cleanings (15 per diskette). Price is \$30. Reader Service number 480.

Power Line Interrupter

Now you needn't worry if the ac line voltage is disrupted or exceeds user-selectable limits. The Power Line Interrupter, with front-panel controls, disconnects power from the controlled apparatus and provides under/over



The AVTEK 1800 system.



ESP Power Line Interrupter.

voltage interrupt level selection and power reset. Other features include integral spike/surge suppression and response delay to prevent false interrupts.

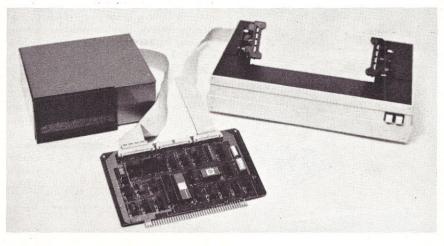
Intended for specialized microcomputer applications where equipment is subject to periods of unattended operation, the interrupter will provide safety and protection for equipment as well as personnel. It connects to the ac line with a standard three-prong plug and can accommodate a 15 Amp resistive load or a 10 Amp inductive load. It is available in two models—over and under voltage (\$142.95) or under voltage only (\$127.95).

Electronic Specialists, Inc., 171 South Main Street, Natick, MA 01760. Reader Service number 479.



Economical, full-color hard-copy reproductions of computer graphics are now available with the introduction of the new Videoprint Systems from Image Resource, 2260 Townsgate Rd., Westlake Village, CA 91361.

The Videoprint 3000 series (\$2990 to \$3550) is used as a hard-copy computer peripheral for the educational, small business and personal



The FP-950 Drive Controller.

computer graphics markets. The Videoprint 5000 series (\$5950) is a higher-performance system, equipped with more flexibility for use by the industrial and commercial computer graphics user.

Both systems are self-contained and fully automatic for minimizing optical distortion, with color, brightness and exposure adjustments under microprocessor control. Both the 3000 and 5000 series produce 4×5 inch hard-copy prints in seconds. Also available are Polaroid SX-70 and 35 mm sizes. The 5000 series has optional controls for unattended operation. Reader Service number 484.

capability and independent motor control.

The new Advance Disk Operating Sys

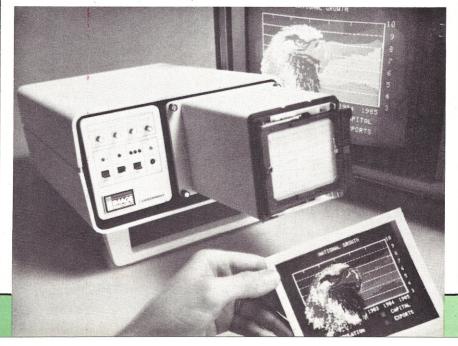
The new Advance Disk Operating System (ADOS) uses a new concept in the file structure which results in quick deletion and compression of files. It allows manipulation of I/O files in buffered sector or block transfer modes up to 63K. Files can be read/write from the editor, monitor, assembler or BASIC language, besides the normal commands for the manipulation of files. The FP-950 is \$475. Single-sided drive with power supply and case is \$375; double-sided drive is \$460.

Applied Business Computer Co., 707G S. State College Blvd., Fullerton, CA 92631. Reader Service number 489.

AIM-65 Floppy Disk Controller

The FP-950 Controller Module for the AIM-65 microcomputer controls up to four two-sided floppy heads (eight heads). It handles either single- or double-density formats and can be programmed for 128, 256, 512 or 1024 bytes/sector. The module can control 35, 40 or 77 tracks/side and features overlapped seek

The Videoprint produces accurate hard-copy records of computer graphics.



Apple II Light Pen

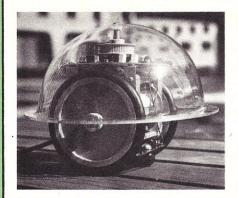
The Lipson Light Pen for the Apple II utilizes a cadmium selenide cell to detect and measure varying intensities of light. It is packaged with 12 BASIC programs on cassette tape, a 48-page manual, all the necessary cable and a connector to PDL(0) on the Apple II.

The manual instructs the user in the methods of detecting and measuring light. It includes demonstration programs (six in Integer BASIC, six in Applesoft) designed to be incorporated into the user's programs, along with tutorial comments and suggestions. Hi-res graphics, sound and color are implemented in the demonstration programs, and the user is encouraged to incorporate the demo routines into programs of his own design. Price is \$24.95.

Aresco, Inc., PO Box 1142, Columbia, MD 21044. Reader Service number 487.

Turtle Interface

The TST-1 is a new interface that plugs into any standard 110 volt wall socket, into any standard serial line and then into the Terrapin Turtle, thus making Turtles completely pluggable for TRS-80, Apple or DEC. The TST-1 provides the Turtle with the parallel interface it needs as well as the necessary 18 volts dc (at 1.5



The Terrapin Turtle.

Amps) of power that it takes to run one of the small Turtle robots. TST-1s may be used to hook up computers directly or may be used for remote input/output. You can also hook up more than one Turtle to a computer, terminal or modem.

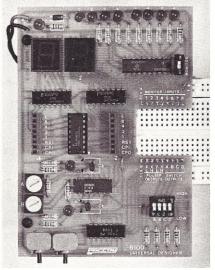
The TST-1 has a settable baud rate to allow it to operate at anywhere from 110 to 4800 baud. Price is \$150, or \$125 with a Turtle.

Terrapin, Inc., 678 Massachusetts Ave., Cambridge, MA 02139. Reader Service number 495.



The CI-1103 memory module is designed specifically for the Heathkit/Digital H11 computer, LSI 11/2 and PDP 11/03 microcomputers. The new memory features an 8K × 16 dual width board using 200 ns 4027 4K \times 1 dynamic memory devices or a 32K × 16 dual width board using 200 ns 4116 16K dynamic memory devices. The unit simply plugs directly into the computers.

The CI-1103 is available with either onboard distributed refresh or external refresh control logic. Data access time is 300 ns, and cycle time is 525 ns. Onboard memory select is available in 2K increments up to 128K words of memory. The 8.44×5.187 inch board is available with battery backup capability. Power consumption is under 7 Watts. Price for the $8K \times 16$ is \$390; the 32K \times 16 costs \$750.



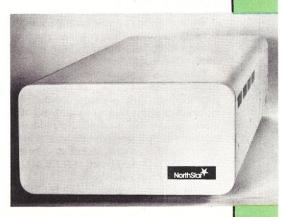
The Paccom 6100 Universal Designer.

Chrislin Industries, Inc., 31352 Via Colinas #102, Westlake Village, CA 91361. Reader Service number 476.

Breadboarding Aid

The Paccom 6100 Universal Designer is an indispensable aid to breadboarding digital ICs from Paccom, 14905 N.E. 30th St., Redmond, WA 98052. By plugging directly into and utilizing Global Specialties or AP breadboarding strips, the 6100 creates a complete breadboarding system providing the most often used inputs and outputs for digital circuit design.

This design accessory features two bounceless push buttons, two seven-segment readouts with binary-coded decimal (BCD) input, four switch outputs, eight LED logic monitors, two variable clock generators, two decade counters and 5 volt supply pins for utilization of up to two breadboard power buses with the main breadboard design strip, for example, one Global Specialties QT-59S and two QT-59Bs. It comes with a schematic diagram, instruction manual and two demonstration experiments: a



North Star hard disk drive system.

two-digit counter and a reaction timer. Reader Service number 498.

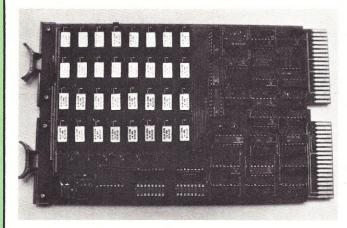
Hard Disk for Horizon

North Star Computers, Inc., 1440 Fourth St., Berkeley, CA 94710, has announced a new Winchester-type 18 MB hard-disk enhancement for its Horizon computers. To back up the information stored on the disk, the information that is modified each day is backed up on floppy disk, on a sector-by-sector basis. This backup and recovery system provides a convenient and inexpensive way to save and restore vital information stored on a hard disk. This system utilizes the Horizon's integral 51/4 inch floppy-disk drives, and data is saved on diskettes only if it has been changed since a previous backup.

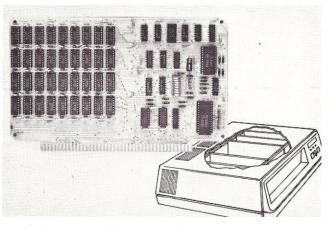
You can add up to four 18 MB Winchestertype disks for a total system capacity of 72 MB. Average access time is 78 ms. Reader Service number 496.

Exorciser Memory

The M64EX is a 64K dynamic RAM micromodule for the Motorola Exorciser and other Exorciser-bus-compatible systems. It features



The CI-1103 memory module.

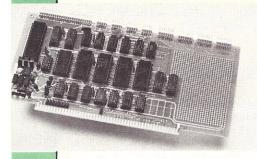


Percom Data's M64EX.

transparent refresh and optional parity check. It also includes an exclusive address translator circuit that accommodates program-controlled memory allocation, which is useful in applications such as multitasking.

The M64EX permits any combination of 4K blocks of RAM-within the upper 32K bytes of memory space-to be enabled or disabled with an onboard DIP switch. This enable-disable capability may be used with the address translator to implement functions such as write protection of program-selected memory blocks. The 64K RAM card is \$875; 48K is \$795. Parity check is \$150 extra.

Percom Data Company, 211 N. Kirby, Garland, TX 75042. Reader Service number



Micromation's multi-user S-100 board.

Multi-User S-100 Board

Micromation, 1620 Montgomery St., San Francisco, CA 94111, announces a multi-user S-100 board that features four RS-232 serial ports with full handshaking capability, three programmable timers, two bus-driving parallel output ports, three parallel input ports with handshake capability, plus a wire-wrap area for custom circuitry.

The four serial RS-232 I/O ports employ individual switch-selectable baud rates to 9600 baud. The four ports use 8551 UARTs to deliver full handshaking and full interrupt support. All UARTs and timers can be interruptdriven for fast system operation.

The board includes an 8253 programmable interval timer, configured as a real-time clock for generating periodic system interrupts. Featuring software-selectable timing, this timer allows you to time events, print the date and time on reports, display the date, minute and hour on the screen and access the time via program software. Reader Service number 491.



France . . . er . . . America . . . er .. New Zealand

With reference to your editorial notes (p. 28, October 1979; p. 2 and p. 46, June 1978): While your admonition about incorrect nomenclature is appreciated (i.e., Baudot's name when the Murray code is intended), your patriotism shows excess.

In fact, Donald Murray was a New Zealander. Born into a North Island farming community, he was of Scottish descent. He graduated BA from Auckland University in 1890, moved to Australia, where he worked as a journalist, and subsequently took an MA from Sydney University. His major subject was logic, particularly symbolic logic. In his articles in the Telegraph and Telephone Journal in 1914 and 1915, Murray remarked that he "knew little of machine technology as such but grasped the underlying principles required for an efficient system." Having these, "what followed was no more than a technological problem."

The Emile Baudot telegraph system using time division multiplex (TDM), to which Murray acknowledges his indebtedness, comprised three parts:

- Some printing mechanisms of the (American) Hughes system.
- Part of the Morse multiplex in which synchronously rotating distributors divided the line between two, three or four printing instru-
- The five-unit code, which had been devised by Gauss and Weber.

The appellation "Baudot Code" is proper only in that the Gauss/Weber code is an adjunct of the Baudot Multiplex Telegraph System. This allocation of code elements is the International Alphabet No. 1. To Baudot goes the credit of being one of the pioneer "systems engineers."

The resemblance between the Baudot and Murray multiplex systems is restricted to the use of synchronously run distributors and a five-unit code. The disparity between the Baudot and Murray codes arises from the difference between the type of keyboard used.

The Baudot transmitter had five keys similar to those of a piano keyboard. Of these, the rightmost three were operated by the right hand (to give, in modern terms, the three least-significant binary bits), while the left hand operated the two most-significant bits. The allocation of combinations of the five keys was arranged to divide finger movement evenly between left and right hands and to minimize it for characters having the greatest frequency of occurrence.

The Murray transmitter used a typewriter keyboard so that the operator had to press only

one key for each character. The allocation of code elements was such that characters occurring with the greatest frequency minimized both the keying operation and wear on the machine parts.

By removing the operator strain and by the inclusion of a tape-loop storage system, the Murray system operated at 40-45 wpm, as against the theoretical 30 and practical 20 wpm of the Baudot. It was in 1898 that Murray took his machine, then in the form of paper-tape control of printers' linotypes, to New York. There it was acquired by the Postal Telegraph-Cable Co., with the object of converting it to a printing telegraph. At this time, Murray took out patents for the future Murray Multiplex Telegraph. After developing this system into an automatic page-printing telegraph, he took it to England, in 1901, where it was taken up by the British Post Office.

From the UK, the Murray Multiplex Telegraph spread rapidly to all countries except the USA, which for four years maintained a tariff barrier against it to protect its own telegraph companies. Notwithstanding that, with some reservations, he had sold his American patents to Western Union, for whom the Murray telegraph equipment was manufactured by the Markrum Company.

As you say, Mr. Green, the credit for the common five-unit code (International Alphabet No. 2) does not go to one of those "confounded Frenchmen." Neither, however, does it go to a confused American, as you claim, but to the New Zealander, Donald Murray.

> T. J. Seed University of Canterbury New Zealand

Computers in Education

Many educational fads have paused in the classroom en route to the storage room; only a few have earned a permanent place in the teacher's array of aids.

The current stars are classroom computers. I am a promoter of their increasing popularity, but the testimonials are as overblown as any touting previous newcomers to the classroom.

Frank Derfler made a start to defining a strategy to encourage newcomers to computers in educational applications (May 1980, p. 150). His approach is internally consistent, but I disagree with his premise that computer-assisted instruction (CAI) is the place to start. CAI is a valid approach to educational computing, but a poor introduction to teachers and programmers for at least two reasons. (1) No matter how transparent the programming, entry of

data consumes time busy teachers can't spare. This effort is better made by full-time programmers serving a broader population. (2) CAI shares this area of education with other quite successful media, programmed texts, for exam-

Mr. Derfler notes applications programmed so far are in mathematics predominantly. Instead, here is a possible alternative to Mr. Derfler's approach.

Accept that the microcomputer is most comfortable in the math room at present and proceed in two ways.

In other disciplines, define and develop flexible data bases to employ the increased capacities now becoming available and to reduce the amount of user time dedicated to information. We need a few Diderots to produce on-line encyclopaediae.

Concurrently, in mathematics, develop the programming formats to make the micro a flexible and convenient aid. Yes, aid. No more, no less. Like the calculator before it, the computer opens new territory to study, so its claim to a space in the math class should be easily established. (CAI is handicapped by its data dependence in this charting-the-unknown capacity.)

Whether other subjects can be similarly expanded remains to be seen. What will transfer well is the programming style developed in math applications. For what they're worth, my goals for a classroom program are:

- Explore concepts beyond the capacity of other media.
- Permit as many student-subject exchanges as possible.
- Meet the teacher at his or her own level, as user, computer beginner or experienced programmer. This implies structured programming and levels of documentation from suggested lessons to variable lists.

The exciting, and threatening, prospect is that we'll be teaching students concepts we don't grasp ourselves; we'll have to learn right along with them.

> **Dave Goforth GO:FORTH Microcomputing** Prince Albert, Saskatchewan Canada

NAVPROG Refinements

I have recently completed entering Leland Young's NAVPROG program, and subsequent corrections, from the February 1980 issue, and have run some tests using FAA charts in the Los Angeles area. The program is fine, and I commend the author for his fine work. However, there appears to be a serious error regarding the computations of the magnetic variations. I have made the following correc-

For stored data, line 280 sends you to line 4000. The processing at line 4000 completes at 4120 or 4150 and returns to 500. The formula for conversion of "easterly" variation to negative is line 490. I suggest 4120 and 4150 read 490, not 500.

Line 4110 uses the magnetic variation and

the degrees thereof to index a variable previously used as an input variable. This violates all I ever learned about programming. In line 4110, I have changed V\$(Q) and V(Q) to V1\$(Q) and V1(Q), respectively. The new variables need dimensioning, and the READ statement in line 210 needs similar changes. The old program merely swapped the first item for the second for the third, etc., and the magnetic courses were wrong in all cases.

> Ronald I. Ruby Tarzana, CA

The comments made by Mr. Ruby are true. The use of V\$(I), V\$(Q), V(I) and V(Q), as in line 4110, resulted from repeated efforts to reduce the program size as much as possible. NAVPROG will work with the variables as listed, but it is a good idea to make the suggested changes. I have since expanded NAV-PROG, and in so doing I had to change the variables as proposed. My thanks to Mr. Ruby for his interest and his comments.

In the vein of "there's always one more bug," it is necessary to include the SGN(X) function in the statement found in line 70: DEF FN S6(X) = INT(X*10 + SGN(X)*.5)/10

This subtle change is necessary to ensure the correct "rounded-off" result for either positive or negative values of X. Heath BASIC requires this change, but Applesoft does not. The difference comes in the way the two BASICs handle the INT(X) function. In Heath BASIC, for example, INT(-3.3) = -3, but in Applesoft the result is -4.

> Leland D. Young Tampa, FL

Two on the 14

Regarding Thomas Prewitt's article on the Heath H14 printer in the February 1980 issue: The article mentioned the light printing using the ribbon furnished by Heath. I would like to make a suggestion.

I replaced the nylon ribbon furnished by Heath with a cotton Teletype ribbon (Nu-Kote #B72). It is a half inch by 12 yards, and also fits Teleprinters 10, 11, 47, 75, 444 and Envoy; plus Olympia SM3 and U50 and Westrex. It has made a big change in my hard copy.

> Howard T. Dempsey Fresno, CA

Author Thomas A. Prewitt submitted the following response to a long letter concerning his article on the Heath H14 Line Printer.-Editors.

After several hours of printing, the H14 may refuse to perform a line feed. The most likely cause for this is simply paper fibers and punchouts from tractor holes. This material collects in the paper feed path and blocks off the phototransistor that monitors the movement of tractor holes in the left edge of the paper to detect paper jams. Correction is as simple as brushing or blowing the foreign material away.

There is a discrepancy between the description of the printhead fuse shown on the schematic and that which appears elsewhere in the manual. The correct part is a 6/10 Ampere slow-blow, not a 1 Ampere fast-blow as shown on the schematic and as a legend on the printed circuit board. Certain forms of circuit component failure can overheat the printhead without blowing the 1 Ampere fast-blow fuse. Printheads are expensive!

> T. A. Prewitt, W9IJ Kokomo, IN

PC Board for Power Supply

O.C. Stafford Electronics Service and Development Company, 427 South Benbow Road, Greensboro, NC 27401, is offering a PC board for the "Mighty Five-Way Power Supply" (April 1980, p. 216).

Part No.	MC-4-80
drilled	\$5.60
undrilled	4.50
chinning	1.00

Don Walters Ann Arbor, MI

Thanks

I continue to see letters from readers complaining about the lack of articles on micros other than the more popular models: TRS-80, PET, etc. My letter, however, is to thank you for "A Not-So-Fast Renumberer for OSI BA-SIC" by John W. Aughey, which appeared in the January 1980 issue.

> Peter Gibbs Mississauga, Ontario Canada

The following was sent anonymously to remind us that we made a mistake in titling Robert Bauman's article in the May 1980 issue "Physician: Automate Thyself."-Editors.

DIFFICULT TO SPELL ... EASY TO UNDERSTAND

H-THAL·MOL'O-GIST

A primary care physician qualified to provice omprehensive diagnostic eye examination for both systemic and ocular diseases and the initiation of medical treatment includir the prescribing of indicated medication an lenses. He is educated, trained and license as a Doctor of Medicine (or Osteopsty) and is the pornal of entry for systems. His education usually includes 4 years of college, plus 4 years of medical school, 1 year of internship and 3-4 years of ophthalmology residency, for a total of 12-13 years of "basic training."

OP TOM'E TRIST



are taking additional classroom training in an effort to expand their services into macologists (M.D.'s) testify that classroom training is inadequate ... and that this trend is a public health.

PHYSICIANS EDUCATION NETWORK INC

EXATRON STRINGY FLOPPY Duners Association Newsletter

Secretary, Fred Waters

Let's put a few ideas together concerning money and taxes. Everyone is aware of the tax revolt that is spreading throughout the land. It started here in California, and it kept on going. What can you as an individual do about it on your own behalf? We've been reading Wayne Green's editorials and publisher's remarks for a long time about producing some income to support your hobby. Last year Personal Computing printed two articles, one by Paul Snigier and another by Mark Battersby, about using your computer to establish a business and get the tax breaks. (For copies, call us.)

LIKE TO BE A BUSINESS?

How would you like to be able to support your computer activities financially-to the point where the costs of equipment, software, magazine subscriptions and the like can be balanced against income, not only that derived from your personal computer, but also that from other sources? Well, Uncle Sam and the IRS would like to help you pay for all this! You don't believe it? Order a Stringy Floppythe fast, accurate, reliable, and inexpensive mass storage device for microcomputers-and join the bandwagon. We'll help you get started in your own business, with all the tax benefits. Read on!

First, a couple of thoughts. You may well ask, why is the Newsletter for the EXATRON STRINGY FLOPPY OWNERS ASSOCIATION-owners of the world's finest alternative mass storage subsystem for small systems-interested in this subject? Good question, and three possible answers. First, the present ESFOA Workshop Chairmen (there are now several hundred, all over the U.S.) are already in just the right situation to set themselves up this way. You chairmen are already acting as focal points for answering questions locally, for demonstrating the ESF to prospects who want to be shown, and for channelling orders back to Exatron, thereby generating income. Second, there are a lot of you ESF owners

who haven't yet decided to act as Workshop Chairmen-your choice-and this might be your incentive. Third, there are a lot of you microcomputer owners who have not yet discovered the Exatron Stringy Floppy, along with all the remarkable benefits of an amazing owners association-full hardware and software support, enthusiastic mutual assistance, interchange of user techniques and ideas, and widespread common backing of this exciting micro-peripheral. Here's a way for those of you in this last group to acquire the ESF and defray all costs.

Another thought. We aren't tax accountants or tax attorneys—we just know how the IRS rules apply to us. Use the information and tips in this newsletter, get a copy of "Tax Guide For Small Business", and consult your own tax advisor.

HOW DO I QUALIFY?

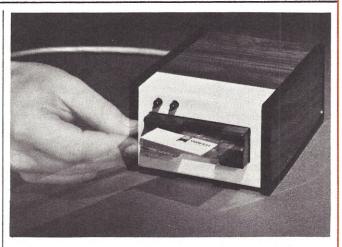
There are several things you must do, and several others you should do, to establish yourself as a bona fide business. First, and most important, the profit motive must be present, and there must be evidence to support this. If you show a net profit in two out of five years, there is a presumption that you are engaged in business for profit. Even when this is not the case, you can demonstrate the intent by supporting activities.

Second, you must keep records. You must choose an accounting method, keep good records of all transactions, and retain copies of all supporting documents. To quote the IRS, "Two characteristic elements of a business are regularity of activities and transactions, and the production of an income."

Evidence of your own skills and expertise help show that the profit motive is present. If you have written a program and sold it to Instant Software, you prove your skills. If you own a Stringy Floppy and have demonstrated it to others in your city, and thereby generate orders and receive bonuses and commissions, you have proven your expertise in that aspect of your computer activities.

If you have any questions about these products, about Exatron or ESFOA please call the Hot Line. Address letters to ESFOA, 3559 Ryder St., Santa Clara, CA 95051.

Stringy Floppy is a trademark of Exatron Corporation.



Call your Program Chairman to get a demonstration of the Exatron TRS-80 Stringy Floppy.

The time and effort you spend on your computer activities is backup for your status as a bona fide business. Even if you have another full-time occupation, you could easily be putting in 10 to 30 hours a week at your business, and this helps to show that you mean it.

If you avail yourself of the paid services of consultants, this again tends to establish your good intention to make a profit. Your cancelled checks for tax advice and technical consulting services are an important part of your records.

Well, here you are. You have set yourself up as a small business, and have in good faith met the standards and qualifications set by the IRS. Your next question would be

WHAT ARE THE BENEFITS?

At this point you have to make a big shift in perspective on the way the tax laws apply. You're probably familiar with the way they work in your case for individual returns, or joint returns for man and wife. For a business it's quite a bit different. To repeat, get a copy of the IRS "Tax Guide For Small Business" and get a tax adviser.

In general, there are credits, deductions, and depreciation. When you acquire capital equipment—which means practically

all hardware, from your computer on down to ESF wafers for program and data storage—you qualify for an investment tax credit of 10% of the cost. There are qualifications to meet, and are other credits available, so check this one out.

Here are some of the items that can qualify as deductions. Software that you buy to operate your business. The cost of trade journals (your Microcomputing subscription), reference books, and education to maintain or improve skills required in your business. Business travel, transportation, and mileage. The costs associated with your attendance at trade shows, or your participation. Check it out!

INFORMATION & ORDERS

The ESF is assembled and tested at the factory, with a 30-day moneyback guarantee and a one-year full warranty. For fastest delivery, phone in your credit card or COD order using the toll-free line below.

Base price for the TRS-80 ESF, \$249.50 (ask about the Starter Kit); for the \$-100 ESF \$289.50. The RS-232 compatible MICROSPONGE is \$349.50 with substantial discounts for OEM quantities. Info packets at no charge; TRS-80 (only) users manuals are \$3 for shipping and handling.

HOT LINE

WITHIN CALIFORNIA

800-538-8559

408-737-7111

WORKSHOP CHAIRMEN

NOTICE: The following is a list of ESF Workshop Chairmen (listed by zip code). If you would like a demonstration of the Stringy Floppy, or if you have any questions about the hardware or software pertaining to the ESF, please feel free to call on the chairman in your area. They will be happy to help you.

WORKSHOP CHAIRMEN (BY ZIP CODE)

T. De Man, Holland John Parker, Port Alberni BC () 723-5861 J.K. Welsh, Burnaby BC (604) 521-3275 Alec Utting, New Zealand (4) 786-524 Karin Golinski, D-6392 Neu-Anspach 1 R.W. Hall, San Carlos, CA (415) 347-9521 Rob Vervlost, Holland Allan Stubbs, Prince George BC () 563-6894 Roy Wallace, Aylmer, Quebec Canada J9H6B5 (819) 684-9087) 563-6894

A.P. McKinley, Saskatoon, SA (306) 343-8887 John Ragle, Amherst, MA 01002 (413) 253-3041 Jack O'Connell, Marlboro, MA 01752 (617) 481-2417

Austin McCollough, Chelmsford, MA 01824 (617) 256-0473 John Pyra, Westford, MA 01886 (617) 692-8070

Jan MacDonald, Bristol, RI 02809 (401) 253-8675
Dr. R.M. Knowles, Cumberland Foreside, ME 04110 (207) 773-7261
Daniel Haggerty, Bangor, ME 04401 945-5547
Wesley Day, Waterville, ME 04901 (207) 873-3955
Rev. Richard Noyes, Madison, ME 04950 (207) 696-5929

(207) 696-5929 (207) 690-9929 Michael Keller, Solon, ME 04979 (207) 643-2437 Thomas Penish, Bogata, NJ 07603 (201) 343-3828 Rev. Edward Collins, Schooley's Mountain, NJ 07870 (210) 876-4395 Ted Kingston, Strathmere, NJ 08248 (609) 263-2440

(609) 263-2440

Major Donald Gober, APO NY 09052 06332-5135 Milton Thrasher, Rye, NY 10580 (914) 967-3322 John Sheil, Levittown, NY 11756 (516) 731-6467 W.C. Hitzmann, Newtonville, NY 12128 (518) 783-9495

Bill Firm, Kingston, NY 12401 (914) 383-1824 George Hadley, Paul Smith's, NY 12970

(518) 327-6413 (518) 327-6413 Lew Daly, Fayetteville, NY 13066 (315) 637-8886 Richard McGarvey, Williamsville, NY 14221 (716) 634-3026 Robert Wynne, Niagra Falls, NY 14303

(716) 285-9391

Gary Wnyder, Rochester, NY 14607 (716) 461-1364

David MacAdam, Rochester, NY 14615 (716) 865-8917

Paul Sturpe, Corapolis, PA 15108 (412) 264-1492 Bill Dalesandry, Pittsburgh, PA 15243 (412) 221-1968 Steven Smith, Altoona, PA 16602 (814) 943-5947

Harold Kautz, Jr., Hershey, PA 17033 (717) 534-2642

(717) 534-2042 Lon Culbertson, York, PA 17404 (717) 843-3425 William Gieske, Nazareth, PA 18064 (215) 837-0223

Carl Killar, Nanticoke, PA 18634 (717) 675-5377 Bruce McIntyre, Langhorne, PA 19047 (215) 322-1895

Richard Landy, Morrisville, PA 19067 (215) 736-0564

Robert Kelch, Glen Burnie, MD 21061 (301) 760-4793

Charles Sutton, Salisbury, MD 21801 (301) 546-0413 Richard Harrison, Warrenton, VA 22186

(703) 439-8109 William Schultze, Fredericksburg, VA 22401

William Schultze, Fredericksburg, VA 22401 (703) 786-8878 William Geer, Falmouth, VA 22401 (703) 371-2019 Stephen Moulton, Virginia Beach, VA 23454

(804) 486-8482 H. Ross Wiant, Grafton, VA 23692 (804) 898-8120

Archie Hubbard III, Bristol, VA 24201 (703) 669-3191

Lawrence Doyle, Eden, NC 27288 (919) 627-0359 William Cornwell, Cary, NC 27511 (919) 467-9156

Micalel Talbot, Raleigh, NC 27612 (919) 787-8082 Kenneth Hendricks, Charlotte, NC 28210 (704) 552-1630

Walter Chandler, Columbia, SC 29210 (803) 781-4822

Lawrence Elliott, Summerville, SC 29483 (803) 873-6765

F.B. Collum, Florence, SC 29501 (803) 662-0421 Herbert Alperin, Atlanta, GA 30342 (404) 231-2310 Owen Black, Augusta, CA 30907 Mark Few, Orlando, FL 32803 (305) 644-7464 J.T. Carlton, Satilite Beach, FL 32937 (305) 773-1590

Richard Nelson, Marathon, FL 33050 (305) 743-9195 Frank Lungarella, Miami Springs, FL 33166 (305) 887-4821

A.J. Catano, Sunmise, FL 33323 (305) 741-4325 R.W. Hopkins, Bradenton, FL 33505 (813) 748-7074 William Howes, Ft. Myers, FL 33907 (813) 482-0347 Bob Jones, Memphis, TN 38138 (901) 363-5469 R.L. Thomas, Jackson, MS 39212 (601) 373-4231 Sumner Loomis, Prairie Pt., MS 39353 (601) 726-5524

L.W. Stein, Independence, KY 41051 (606) 371-3242

W.H. Jenkins, Canal Winchester, OH 43110 (614) 837-2325

G.C. Hufnagle, Rickenbacker AFB, OH 43217 (614) 491-1101

L.R. Snowden, RAFB, OH 43217 (614) 497-0838 L.C. Graham III, Barnesville, OH 43713 (614) 425-3633

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Get Your Pet on The IEEE 488 Bus

This 3-part odyssey takes you along route 488. The first stop is here . . . tickets, please.

Gregory Yob Box 354 Palo Alto, CA 94301

perhaps the most obscure Commodore PET feature is its IEEE 488 (or HPIB or GPIB) interface. This three-part article describes the rudiments of the 488 bus and how to use your PET to communicate with instruments having the 488 interface. Several working examples with Hewlett-Packard equipment are shown. (HP lent me several 488-compatible instruments to prepare this article.)

If you just want your PET to talk to that costly instrument on your bench, skip this month's installment and start next time with part 2. The first two parts of this article will sketch the prerequisites and give you enough information to track down bugs on your own.

What's a 488 Bus?

In 1972, engineers - some with Hewlett-Packard-proposed a method of joining many instruments in a standardized way to help automate lab and test measurements. This resulted in the IEEE Standard 488-1975, which describes how to connect as many as 15 instruments on the same cable.

HP and several other laboratory-instrument manufacturers then offered the IEEE 488 scheme as an option. Presently, several hundred instruments have the 488 capability; Commodore used to provide a 5-page list of these. The PET was later designed with the instrumentation and control market in mind, so the IEEE 488 interface was put into the PET.

Before the introduction of the PET, instruments capable of controlling the 488 bus cost several thousand dollars. Now the PET often costs less than the instruments it controls. Some 488 manufacturers have trouble adjusting to this - their customers balk at the idea of purchasing an \$800 microcomputer to control a \$30,000 instrument!

Now one connector joins the PET to many peripherals. You

don't need a separate interface and connector for each new gadget. Commodore's printer and disk are designed to use the PET's 488 interface.

Physical Aspects

A PET and a 488-compatible device have different connectors. Your first project is to wire a cable to tie the two machines together.

Fig. 1 shows the location of the IEEE 488 connector on the back of the PET, and Fig. 2 describes the pins and connectors used for the PET and the IEEE 488. I used a 20-conductor ribbon cable and tied the

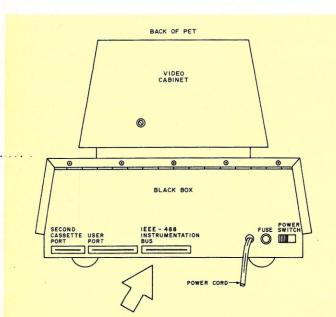


Fig. 1. Location of PET IEEE 488 port on the back of the PET next to the power switch and fuse.

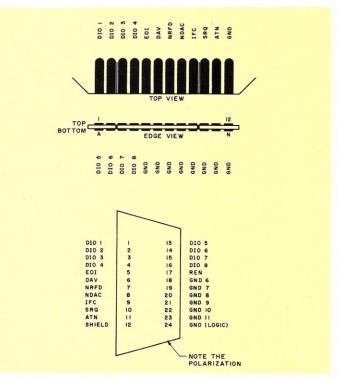


Fig. 2. Pin-outs and connectors for the IEEE 488.

grounds together into the four lines left over after I connected the signal wires.

When making the cable, bear in mind that there are strict limits to cable lengths:

- 1. The maximum distance between two devices is 5 meters.
- 2. The longest distance from one end of your setup to the other is 20 meters.
- 3. A maximum of 15 devices, including the PET, can be hooked together.

It is also wise to avoid electrically noisy areas; don't drape your IEEE 488 cable over your TV set.

If more than one device is connected to the 488, you must use extension cables. HP has cables for about \$50. If you want to make your own, consult the two configurations in Fig. 3. The 488 instruments always have a female connector, so have an excess of male connectors on your cables.

Electrically, the 488 bus works on an active-low principle. Fig. 4 shows a circuit similar to a 488 bus line. When all the switches are open, the voltmeter will show 5 volts, which is the false state (or 0) for the line. If any of the switches are closed, the line is grounded, and the voltmeter shows zero volts, or the true state.

This peculiar arrangement permits several devices to be connected to the same line. If any one of them has a switch closed, the line is true. Devices frequently operate at different speeds, and when each device is ready, it opens its switch. However, the line remains true (low) until the slowest device opens its switch.

IEEE Blinkin Lites Display

It is always convenient to have a display and switches to perform a front panel function

when you debug interfaces. I built a box, which I call the 488 Blinkin Lites, to display the states of each of the IEEE 488 lines and some switches to force lines low if needed. Fig. 5 shows the circuit, and Fig. 6 is a sketch of my box.

Each line is pulled up to +5 volts with a 10k resistor-the high value was chosen to minimize the load on the 488 bus. The switches can override any line when they are closed to ground. Though the PET doesn't use all the IEEE 488 lines, future machines will - so I put them all in my box.

If you build this box, don't use the PET's +5 volts from the tape port-the LEDs draw 170 mA, which is too much for the PET. Provide a connector to the PET's IEEE port and a male and female IEEE connector. This lets you interpose the IEEE Blinkin Lites between the PET and an instrument

I mounted a 5x7 inch perfboard with 0.10 inch holes into a standard breadboard box and placed a label near each switch/ LED combination to identify the IEEE lines. The three ICs are the 7404s used to drive the LEDs. The cable leads to a homemade junction with a PET connector and IEEE male and female connectors. A mini phono jack connects to a separate +5 volt supply (see Fig. 6).

When you plug in the IEEE Blinkin Lites, the LEDs will show the state of the lines - an LED that is off indicates a low line, which is true; an on LED indicates high, which is false.

The IEEE 488 Lines

The IEEE 488 is composed of 16 lines. Eight are for transfer of data, five are for bus management and three are for handshaking. The eight data lines are

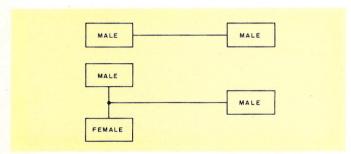


Fig. 3. Convenient cable configurations for the IEEE 488 bus.

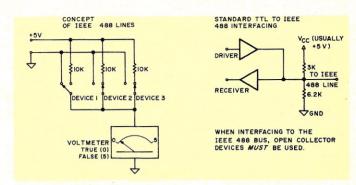


Fig. 4. IEEE 488 equivalent circuits. The lower circuit is the standard method of connecting TTL logic to the 488 bus. The driver must be an open collector and able to sink at least 48 mA at .4 volts and source 5.2 mA at 2.4 or more volts. The PET uses MC 3446P bidirectional line interface ICs for this function.

labeled DIO1 through DIO8, with the most significant bit (MSB) on DIO8. The 488 bus can transfer one byte at a time and is sometimes called byte-parallel.

The five bus-management lines in various combinations and sequences provide many bus facilities, most of which are rarely used:

EOI - End of Message. When a group of bytes is sent via the DIO lines, EOI is made true on the last byte to indicate that the message is completed. This is optional, and many instruments send the ASCII characters CR and LF as data instead. Check your instrument's manual.

IFC-Interface Clear. When this line is true, all instruments disconnect to a defined state. (This usually is unaddressed and untalked.) When you turn on the PET, IFC is true for about 100 ms. If the PET is reset, IFC will again be true.

SRQ-Service Request. This permits an instrument to signal that it needs attention . . . and the device in charge of the bus must find out what it needs. The PET has this line as an input, but it takes some programming effort to use SRQ; most instruments don't use SRQ.

REN - Remote Enable, Most IEEE instruments have front panels that permit stand-alone operation-that is, they work as ordinary instruments when the 488 bus isn't connected. REN lets the instrument disconnect from the bus and be controlled from its front panel.

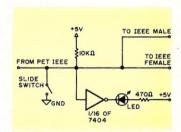


Fig. 5. IEEE "Blinkin Lites" circuit. Each IEEE line uses one copy of this circuit.

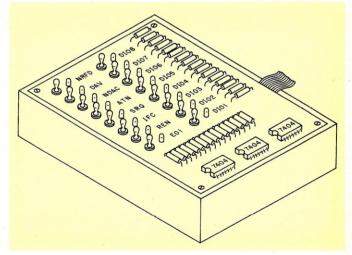


Fig. 6. Sketch of the "Blinkin Lites."

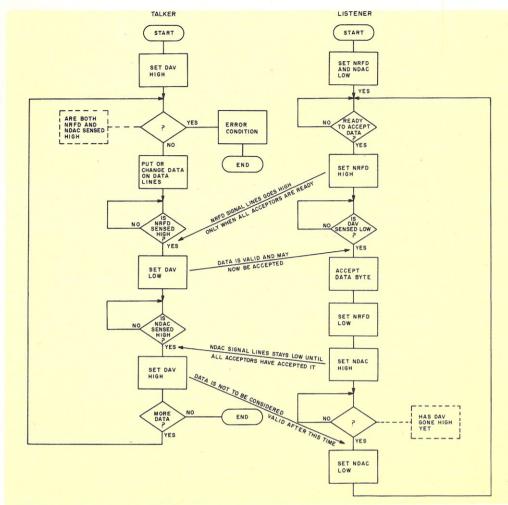


Fig. 7. The IEEE 488 handshake reproduced from Electronics, Nov. 14, 1974, p. 98, as reproduced in HP part #5952-0058.

The PET's REN line is always arounded.

ATN-Attention. This is the most relevant line for this article. It tells the device whether to regard the data on the DIO lines as a command or as data. When ATN is true, the byte on the DIO lines is a command. When ATN is false, DIO is seen as data

The three handshake lines are used to pass bytes on the DIO lines. When a byte is transferred, the slow devices will keep one or more of the handshake lines true until they are finished. This ensures that data is passed at the speed of the slowest device and isn't lost.

The handshake lines are:

DAV (Data Valid) - When this line is true, the data on the DIO lines is correct and the receiving instruments can pick up the byte.

NRFD (Not Ready For Data) -When a receiving device is busy or is still processing prior data, it will make NRFD true, which stops data transfers.

NDAC (Not Data Accepted) -When the data is on the DIO lines, the receiving devices keep NDAC true until all of them have read the data byte. Note that the handshake lines don't care whether the data is a command or not; every byte of data or command has to undergo the handshake sequence.

The Handshake

For data transfer, one device is the "talker," which provides the data or commands for transfer. The recipients, or "listeners," pick up the data, and more than one device may listen at the same time. The handshake specifies exactly how the data transfer is accomplished.

Fig. 7 shows a flowchart of the handshake sequence. When the first event, NRFD, goes false, this tells the talker that all of the listeners are now ready to receive a new data byte. The slowest listener is the last one to release NRFD, which will go high.

Next, the talker puts the data byte on the DIO lines and waits briefly to let the signals settle (usually about 10 µs). Once the data is on the DIO lines, NRFD is checked by the talker; if it is false, the talker sets DAV to true. The listeners now know that the new data is ready for pickup. (If NRFD is true, the talker waits until it goes false.)

The first listener that detects DAV true now sets NRFD true, and all of the listeners pick up the data byte from the DIO lines. Up to now, NDAC has been true, and as each listener gets its



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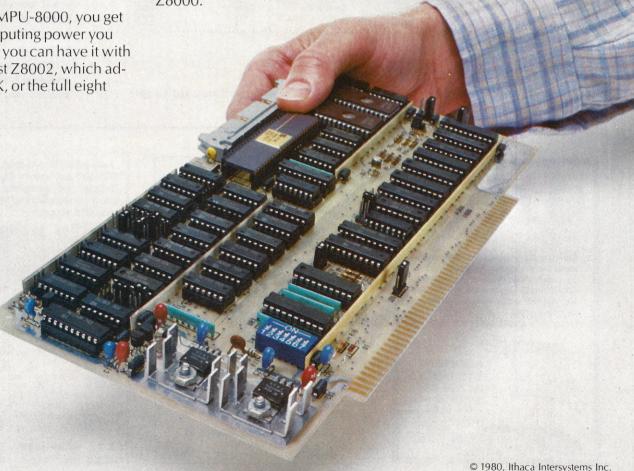
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byte, it releases NDAC. NDAC goes false when all the listeners have the data. The talker waits for NDAC to go false, and when it does, the talker sets DAV to false. The listeners then make NDAC true, and the entire handshake sequence begins again.

Since a device is either a listener, talker or not addressed, Fig. 7 is broken into two flow-charts: one for the talker and

one for the listener. A listener will start the handshake with NRFD and NDAC true, while the talker checks these. If both are false – the listener isn't there – an error condition exists.

Commands and Messages

When ATN is true, any data on DIO is seen as a command. Fig. 8 shows the entire ASCII set of 128 characters devoted to IEEE

Table 1. All PET I/O lines.

IEEE	488 F	PIA (65	520)		ADDR	ESS:	\$ E820		59	424
PAØ	IEEE	Data I	n 1		PBØ	TEEE	Data	Out	1	
PA1	11	11	2		PB1	11	11		2	
PA2	11	11	3		PB2	11	11		3	
PA3	110	11	4		PB3	1.1	11		4	
PA4	11	11	5		PB4	11	11		5	
PA5	11	11	6		PB5	11	11		6	
PA6	11	111	7		PB6	11	110		7	
PA7	11	11	8		PB7	11	11		8	
CA1	ATN I	n			CB1	SRQ	In			
CA2	NDAC				CB2	DAV (

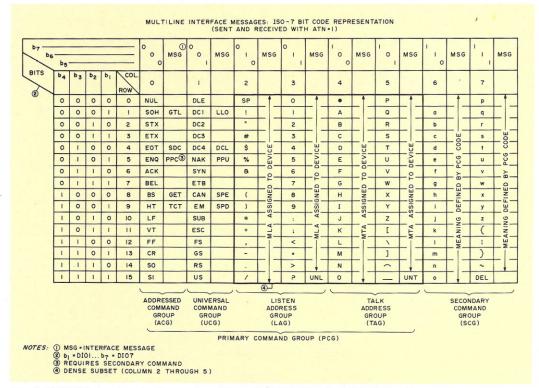


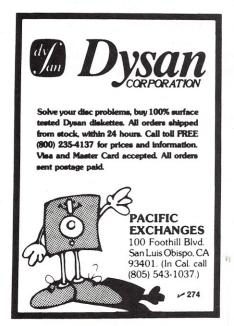
Fig. 8. IEEE 488 command set reproduced from the IEEE Standard 488-1975/ANSI MC 1.1-1975, p. 77.

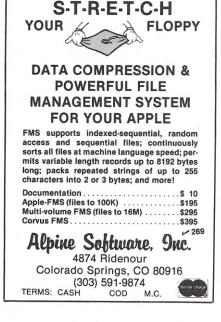
488 commands.

The ASCII codes 32 through 62 (all numbers in decimal) designate the listen address for a device. Most IEEE-488-compatible devices have a five-position DIP switch next to the 488 connector set to the device's address, a number from 0 to 31. (Note: For the PET, use 4–15.) When the listen address is sent with ATN true and this address matches the device's address, the device will now be addressed to listen and will accept any data sent with ATN false.

If the device is supposed to send data, the talk address—from ASCII codes 64 through 94—will be used instead. The device (if with matching address) will now send data bytes to the bus.

If the device's address (by the switches) is number 7, the listen address value will be 32+7, or





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KEYB	OARD PIA (6520)	ADDRESS: \$ E810 59408	USER PORT VIA (6522)	ADDRESS: \$ E840 59456
PAØ	Keyboard Row Select, LSB	PBØ Keyboard Column A	PAØ User Port LSB	PBØ NDAC In
PA1	0 0	PB1 " " B	PA1 " "	PB1 NRFD Out
PA2		PB2 '' ' C	PA2 II II	PB2 ATN Out
PA3	II II MSB	PB3 " " D	PA3 '' ''	PB3 Write, Both Cassettes
PA4	Switch, Cassette #1	PB4 '' '' E	PA4 " "	PB4 Motor, Cassette # 2
PA5	11 #2	PB5 " " F	PA5 '' ''	PB5 Video Horiz Sync In
PA6	EOI In	PB6 '' '' G	PA6 " "	PB6 NRFD In
PA7	Diagnostic Jumper	PB7 '' '' H	PA7 " " MSB	PB7 DAV In
A1	Read, Cassette #1	CB1 Video Horiz Sync In	CA1 User Port Handshake	CB1 Read, Cassette #2
CA2	Screen Blank & EOI Out	CB2 Motor, Cassette #1	CA2 Characters ROM Select	CB2 User Port Handshake
The	Diagnostic LED will light if	PAØ-High, PA1-High, PA2-Low, PA3-High.	CA2 selects the MSB of the characters	

39 (apostrophe). The talk address will be 64 + 7, or 71 (letter G). Notice that bits 5-7 designate talk or listen, and bits 0-5 designate the address. Address 31 is reserved for two special commands. Although you can set the switches on a device to 31, it won't operate with this settina.

One instrument must provide these talk and listen addresses. This device is the controller, and the PET is always the controller. The controller can talk and listen too, but only the controller can set ATN true.

Two of the ASCII codes, 63 and 95, serve as "universal" commands. The 63 code is known as "unlisten" and tells all addressed devices to stop listening to the bus. This is faster than trying to tell the devices one at a time to stop listening. The 95 code, "untalk," stops all data transmitters (talkers).

When a message - or a group of data bytes-is sent on the 488 bus, the controller sets ATN true and sends a listen address: the controller sets ATN true and sends a talk address; the talker puts data on the bus, and the listener picks it up. When the talker is finished, it may set EOI true on the last byte or send CR LF as the last bytes. The controller now sets ATN true and sends untalk (UNT) and unlisten (UNL), which reset the two de-

vices.

In many cases, the controller -in this case, the PET-does the talking or listening. The controller can make everything stop by either setting IFC true or setting ATN true and putting UNT on the bus. Since UNT has its five lowest significant bits true, the active low operation of the IEEE lines overrides whatever data is present. (In normal operation of the bus, the controller doesn't have to take these

```
Listing 1. Memory Monitor.
```

```
10 PRINT"cir sp sp sp sp sp sp sp --> MEMORY MONITOR <--
20 PRINT"dn sp sp THIS PGM DISPLAYS A LOCATION IN THE
30 PRINT"PET'S MEMORY IN BOTH DECIMAL AND IN A
40 PRINT"FRONT PANEL' FORMAT.
50 PRINT"dn sp sp YOU CAN CHANGE THE ADDRESS OR VALUE
60 PRINT"BY ENTERING A NEW VALUE WHEN THE '>>'
 70 PRINT"MARKER IS NEXT TO THE ITEM YOU ARE 80 PRINT"CHANGING.
80 PRINT"CHANGING.
90 PRINT"dn sp sp PRESS 'RETURN' TO ENTER THE CHANGE
100 PRINT"GR TO MOVE THE MARKER.
110 PRINT"dn sp sp THE PGM CONSTANTLY PEEKS THE LOCATION
120 PRINT"WHEN YOU AREN'T CHANGING A VALUE. IF
130 PRINT"WILL SHOW THE NEW VALUE. IF PGM
140 PRINT"WILL SHOW THE NEW VALUE. IF YOU CHANGE
150 PRINT"M VALUE, IT IS POKED INTO MEMORY.
160 PRINT"dn sp sp 'H' WILL GIVE YOU SOME HELP FOR EACH
170 PRINT"ITEM.
190 PRINT"ITEM.
190 PRINT"dn PRESS ANY KEY TO START
195 GETA$:IFA$=""THEN195"
200 REM DRAW DISPLAY FORMAT
              NOTE: For Lines 200-320 see Fig. 9.
 400 REM IDLING PROGRAM
 500 REM DISPLAY ADDRESS
 520 REM DISP PANEL LITES
525 DT=PEEK(AD)
 530 GOSUB 1200
540 REM DISP DECIMAL
 550 GOSUB 1400
 560 REM DISP PTR
570 GOSUB 1600
 580 REM GET CHAR
590 GET A$
600 IF A$="" THEN 500
```

```
610 IF A$=CHR$(13) THEN 700
620 FG=Ø:GOSUB 2500
      IF FG=Ø THEN 510
640 GOTO 210
 700 REM BUMP PTR
 710 GOSUB 1800
 720 GOTO 510
1010 PRINT"hm dn dn dn dn dn dn dn"
1020 V$=STR$(AD)+"sp sp sp sp sp sp sp sp
 1030 V$=MID$(V$.2.6)
 1040 PRINT TAB(20); V$
1050 RETURN
 1200 REM DISP PANEL
1210 PRINT"dn dn dn"TAB(11);
1220 VT=DT:DV=128
1230 FOR J=1 TO 8
1240 IF VT/DV≤1 THEN 1260
 1250 PRINT" Q r+";:VT=VT-DV:GOTO 1300
1260 PRINT" W r+";
1310 NEXT J
 1400 REM DISP DECIMAL
 1410 PRINT"dn"
1420 V$=STR$(DT)+" sp sp sp sp sp sp sp sp sp "
 1430 V$=MID$(V4,2,6)
1440 PRINT TAB(2Ø);V$
 1450 RETURN
 1600 REM DISP PTR
1600 REM DISP PTR
1610 PRINT"hm dn dn dn dn dn dn dn dn
1620 IF PT >1 THEN 1640
1630 PRINT TAB(8)">>"; :RETURN
1640 PRINT"dn dn dn"
1650 IF PT >2 THEN 1670
1660 GOTO 1630
1670 PRINT"dn":GOTO 1630
1800 REM BUMP PTR
1820 PRINT"rt rt sp sp"
1830 PT=PT+1: IF PT >3 THEN PT=1
1840 GOSUB 1600
1850 RETURN
                                      (This line probably isn't needed)
2510 ON PT GOSUB 3000,3500,4000
2520 RETURN
3000 REM CHANGE ADDR
3010 IF A$="H" THEN GOSUB 4500:RETURN
```

VALUES FO	RINPUTS			VALUES FO	ROUTPUTS		
IEEE LINE	ADDRESS (HEX)	ADDRESS (DECIMAL)	В,ІТ	IEEE LINE	ADDRESS (HEX)	ADDRESS (DECIMAL)	BIT
DIO 1	E820	59424	0	DIO 1	E822	59426	0
DIO 2	E820	59424	1	DIO 2	E822	59426	1
DIO 3	E820	59424	2	DIO 3	E822	59426	2
D10 4	E820	59424	3	DIO 4	E822	59426	3
D10 5	E820	59424	4	DIO 5	E822	59426	4
DIO 6	E820	59424	5	DIO 6	E822	59426	5
DIO 7	E820	59424	6	DIO 7	E822	59426	6
D10 8	E820	59424	7	D10 8	E822	59426	7
EOI	E810	59408	6	EOI	E811	59409	3
IFC			-	IFC			-
SRQ	E823	59427	7	SRQ			-
REN			-	REN			-
ATN	E821	59425	7	ATN	E840	59456	2
DAV	E840	59456	7	DAV	E823	59427	3
NRFD	E840	59456	6	NRFD	E840	59456	1
NDAC	E840	59456	0	NDAC	E821	59425	3

Table. 2 Addresses and bits for the IEEE 488 lines.

drastic measures.)

In some cases, a device will have a secondary address, which permits more than 31 effective addresses on the bus. For example, the Commodore printer might be set as device 4. To control internal functions,

secondary addresses select the function in use. (See Commodore's "PET Communication with the Outside World," p. 19.) If a secondary address is in use, it is sent immediately after the talk or listen address, known as the primary address, with ATN

true

Several of the bus-management lines, such as SRQ, EOI, REN and IFC, serve special functions. Many instruments do respond to these, and often the response depends upon the instrument.

When ATN is low, about half the ASCII code is devoted to special commands, which come in defined sequences whose definition takes about twothirds of the formal IEEE 488 specification. Most instruments use only a few of these.

Flipping Bits

The PET ultimately communicates to the rest of the world by the screen and some interface chips-two 6520s and one 6522. (For the specs on these chips, contact MOS Technology.) The 6520 and 6522 chips can only drive one TTL load, so the PET's IEEE lines are connected to some buffer chips to provide the currents needed in the IEEE 488

Table 1 indicates all of the PET's I/O line assignments as a reference. The PET utilizes all 60 I/O lines as shown here. Most of the IEEE lines are buffered with MC 3446P bidirectional line

```
3020 V1=AD
 3030 GOSUB 5000
3040 IF V2 Ø THEN RETURN
3050 IF V2 65535 THEN RETURN
 3060 AD=V2:RETURN
 3500 REM CHANGE BINARY VALUE
 3510 IF A$="H"THEN GOSUB 4600: RETURN
  3520 V1=DT
3530 GOSUB 5500
3540 IF V2 Ø THEN RETURN
3550 IF V2 > 255 THEN RETURN
3560 DT=V2:POKE AD, DT:RETURN
4000 REM CHANGE VALUE
4010 IF A$="H" THEN GOSUB 4500: RETURN
 4020 V1=DT
4030 GOSUB 5000
4040 IF V22 Ø THEN RETURN
4050 IF V2>255 THEN RETURN
4060 DT=V2:POKE AD,DT: RETURN
4500 PRINT"cir sp sp TYPE IN THE NEW NUMBER AND PRESS
 4510 PRINT"RETURN. PRESS 'X' TO ABORT & NOT MAKE
4515 PRINT"THE CHANGE.
4520 PRINT" sp sp PRESS SPACE TO ERASE REST OF NUMBER.
4530 PRINT" dn sp sp PRESS ANY KEY
4540 GETA$: IFA$=""THEN 4540
4550 RETURN
4600 PRINT"CIr sp sp ENTER '1' OR 'Q' TO SET A BIT, AND 4610 PRINT"'Ø' OR 'W' TO RESET A BIT. PRESS 4620 PRINT"ETURN WHEN DOEN. 4625 PRINT" sp sp PRESS SPACE TO SKIP A BIT. 4630 PRINT"dn sp sp PRESS ANY KEY 4640 GETAS: IF A$="" THEN 4540
4650 RETURN
5000 REM NUMERIC ENTRY
5010 REM POS CURSOR
5020 PRINT TAB(20);
5030 REM MAKE DISP STR
5040 D$=MID$(STR$(V1),2)+"sp sp sp sp sp sp sp sp"
5050 D$=LEFT$(D$,6)
5060 REM SET RVS PTR & RETURN VALUE
5070 PC=1: V2=-1
5000 PC=1:V2=-1

5080 REM SEE INPUT & ACT

5090 IF A$="X" THEN RETURN

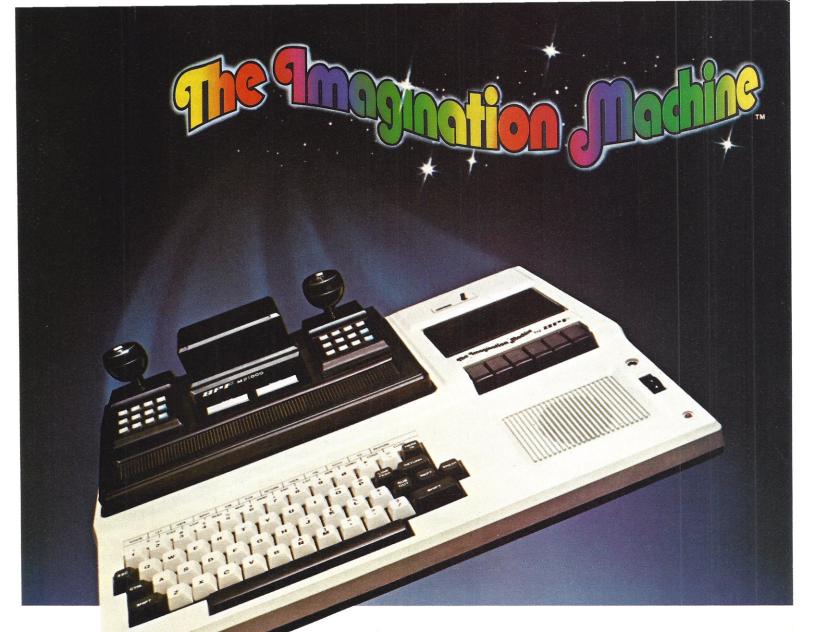
5100 IF A$=CHR$(13) THEN V2=VAL(D$):RETURN

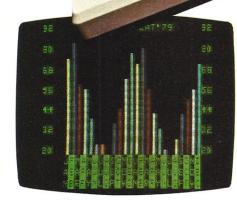
5110 IF A$<" sp" THEN 5120

5112 IF PC=1 THEN D$="sp sp sp sp sp":G$T0 5210

5114 D$=LEFT$(D4,PC-1)+"sp sp sp sp sp sp":D$=LEFT$(D$,6)
5118 GOTO 5210
5120 IF A$< "Ø" OR A$ >"9" THEN 5210
5125 REM REMAKE STRING
```

```
5130 DX$=D$:D$=""
 5140 FOR J=1 TO 6
5150 IF PC=J THEN D$=D$+A$:GOTO 5170
 5160 D$=D$+MID$(DX$,J,1)
 5170 NEXT
 5180 PC=PC+1: IF PC >7 THEN PC=1
 5200 REM DISPLAY RESULT & RESTORE CURSOR
 5210 FOR J=1 TO 6
5220 IF J=PC THEN PRINT "rvs";
5230 PRINT MID$(D$,J,1);
5240 IF J=PC THEN PRINT "off";
5250 NEXT J:PRINT"Ift Ift Ift Ift Ift Ift;
5260 GET AS: IF AS="" THEN 5260
5270 GOTO 5090
 5500 REM BINARY ENTRY
5510 PRINT TAB(11);
 5640 GETA$: IFA$=""THEN 5640
5650 GOTO 5600
5660 REM REMAKE STRING
5670 DX$=D$:D$=""
5680 FOR J= 1 TO 8
5690 IF PC=J THEN D$=D$+A$: GOTO 5710
 5700 D$=D$+MID$(DX$, J, 1)
5710 NEXT J
5720 REM DISP & FIX CURSOR 5730 FOR J= 1 TO 8
5760 GOTO 5640
5770 REM MAKE VALUE
5780 V2=Ø:FORJ=1 TO 8
5785 V2=V2*2
5790 IF MID$(D$,J,1)=" W " THEN 5810
5800 V2=V2+1
5810 NEXT J
```





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driver chips to provide the IEEE current requirements. SRQ is an input only and connects directly to the 6520 chip. IFC is buffered

with a NAND and some resistors to the IEEE specification.

Table 1 reveals some interesting irregularities concerning the IEEE 488 bus: If EOI is true, the PET's display is turned off. (Programs that PEEK and POKE the display area in memory can use this to avoid snow.) Latermodel PETs don't have this problem. REN isn't listed; the PET's REN line is wired to ground (true). IFC is not shown. The PET's IFC is connected to the power-on one-shot, which sets IFC true for about 100 ms when the PET is turned on. If you reset the PET by grounding the RES line, IFC may not go true. A better approach is to trigger the power-on one-shot by inserting a switch between power and the 555's power pin. The SRQ line is an input only. The PET's firmware does not use SRQ, so you have to program it directly.

In a 650x-based system, all I/O is seen as a set of memory addresses. This means that BA-SIC's PEEK and POKE can be used to control the IEEE 488 lines. Table 2 indicates the addresses and bits involved for the PET's IEEE lines. In most cases, a direct PEEK or POKE will do. Two lines, ATN in and SRQ in, require a more complex sequence. These are connected to CA1 and CB1 of a 6520, which set flag

bits in the Interrupt Flag register. Resetting these bits reguires a memory access to the DIO data register.

Table 3 lists the specific PEEKs and POKEs to individually sense or modify the IEEE lines. In many cases the PEEK or POKE values can be ANDed or ORed together to do several operations at once. If you have built the IEEE Blinkin Lites, try a few of these PEEKs and POKEs to see how they work.

When I was flipping bits with PEEK and POKE for the IEEE lines, I was confused each time I had to figure out the decimal numbers for each changed bit. Perhaps it would be easier to display a byte of memory on the PET's screen in a "front panel" format with simulated LEDs for each bit and some simple keyboard commands to change bits and addresses. Memory Monitor (see Listing 1) does this.

When Memory Monitor is loaded and run, and the first page of instructions is read, the display in Fig. 9 is shown. A box with four parts appears in the middle of the screen with the title Memory Monitor placed above the box. Left of the box is a marker, >>, which indicates the part of the box accessible by the keyboard.

The top of the box shows the

```
All DIO Lines:*
              POKE 59426,255:V = PEEK(59424):V = (NOT(V))AND255
      OUT:
              V = (NOT(V))AND255: POKE 59426,V
EOI
              V = 1:IF PEEK(59408)AND 64 THEN V = 0
        IN:
 TRUE OUT:
              POKE 59409, PEEK(59409) AND 247
              POKE 59409, PEEK(59409) OR 8
FALSE OUT:
SRO**
        IN:
              V = 0:IF PEEK(59427) AND 128 THEN V = 1
              7 - PEFK/59426)
      I O-HI
              POKE 59427, PEEK(59427) OR 2
      HI-LO
              POKE 59427, PEEK(59427) AND 253
ATN**
              V = 0:IF PEEK(59425) AND 64 THEN V = 1
        IN:
              Z = PEEK(59424)
      LO-HI:
              POKE 59409, PEEK(59409) OR 2
     HI-LO:
              POKE 59409, PEEK(59409) AND 253
 TRUE OUT:
              POKE 59456, PEEK(59456) AND 251
              POKE 59456, PEEK(59456) OR 4
FALSE OUT:
DAV
        IN.
              V = 1: IF PEEK(59456) AND 128 THEN V = 0
 TRUE OUT:
              POKE 59427, PEEK(59427) AND 247
FALSE OUT:
              POKE 59427, PEEK(59427) OR 8
NRFD
              V = 1: IF PEEK(59456) AND 64 THEN V = 0
        IN:
 TRUE OUT:
              POKE 59456, PEEK(59456) AND 253
              POKE 59456, PEEK(59456) OR 2
FALSE OUT:
NDAC
        IN:
              V = 1: IF PEEK(59456) AND 1 THEN V = 0
 TRUE OUT:
              POKE 59425, PEEK(59425) AND 247
              POKE 59425, PEEK(59425) OR 8
FALSE OUT:
*The extra parenthesis in the complementation of V is required, for the PET
```

SRQ OUT is not available on the PET.

Be sure to reset the flag bit before checking the first time.

evaluates AND before NOT.

Table 3. PEEKs and POKEs for the IEEE 488 lines.

**The HI-LO or LO-HI determines which transition the CA/CB1 inputs will respond

to. Set the HI-LO or LO-HI before doing the IN: line. The Z = PEEK resets the flag bit.

```
Listing 2. BASIC 488 program.
                                                                                                                                                                                      7500 PRINT"cir SEND MESSAGE"
7510 INPUT"dn dn MESSAGE:";0
                                                                                                                                                                                      7520 D2=FNF(DV+32):GOSUB9450:GOSUB8500:GOSUB9470
                                                                                                                                                                                      7530 FOR J=1 TO LEN(C$)
7530 FOR J=1 TO LEN(C$)
7540 D2=FNF(ASC(MID$(C$,J)))
7550 GOSUB8500:NEXTJ
 1000 REM **** IEEE 488 ****
1005 REM GREGORY YOB, JAN 1979
 1010 REM
1015 REM
                       BOX 354, PALO ALTO CA 94301
                                                                                                                                                                                      7560 PRINT"dn dn MESSAGE SENT: sp"C$
 1020 REM THESE ROUTINES PERMIT DIRECT
1025 REM MANIPULATION OF THE PET IEE
1030 REM 488 BUSS LINES AND (SLOW!)
1035 REM IEEE 488 COMMAND AND DATA
                                                                                                                                                                                     8000 PRINT"cir LISTEN HANDSHAKE dn"
8010 GOSUB9350:GOSUB9250:GOSUB9370
8020 PRINT" sp NRFD TRUE dn":PRINT" sp NDAC TRUE"
:PRINT" sp NRFD FALSE"
8030 PRINT"MAITING FOR DAV TRUE"
8040 GETA$:IFA$
""THENPRINT"--FORCED":GOTO8060
8050 GOSUB9100:PRINT"dn spDATA:"FNF(D1)CHR$(FNF(D1))
8070 GOSUB9000:PRINT"dn spDATA:"FNF(D1)CHR$(FNF(D1))
 1040 REM TRANSFERS
1045 REM

1500 REM -- INITIALIZATION --

1510 RESTOR: READ A1, A2, A3, A4, A5, A6, A7

1520 DATA 59424, 59426, 59425, 59427, 59408, 59456, 59409

1530 READ MØ, MI, M2, M3, M4, M5, M6, M7

1540 DATA 1, 2, 4, 8, 16, 32, 64, 128

1550 READ NØ, NI, N2, N3, N4, N5, N6, N7

1560 DATA 254, 253, 251, 247, 239, 223, 191, 127
                                                                                                                                                                                     8070 GOSUB9350:GOSUB9270
8080 PRINT"dn sp NRFD TRUE":PRINT" sp NDAC FALSE"
8090 PRINT"MAITING FOR DAV FALSE"
8100 GETA$::FA$
    ""THENPRINT"--FORCED":GOTO8120
8110 GOSUB9100:IFH1=1THEN8100

 1580 DATA 255
1590 READ 01,02,03,04,05,06,07
1600 DATA 255,266,60,60,249,255,60
1610 DEF FNF(X)=(NOT(X))AND255
                                                                           (Each of these is Letter 0)
                                                                                                                                                                                     8120 GOSUB9250
                                                                                                                                                                                     8130 PRINT"dn sp NDAC TRUE"
8140 RETURN
 1620 RETURN
7000 PRINT"clr GET MESSAGE!
                                                                                                                                                                                     8500 PRINT"cir TALK HANDSHAKE"
                                                                                                                                                                                     8510 GOSUB9170
8520 PRINT"dn sp DAV FALSE"
8530 GOSUB9200:GOSUB9300
7010 PRINT"dn PRESS KEY TO START"
7020 GETA$:IFA$=""THEN RETURN
                                                                             ("" is an empty string)
 7030 D2=FNF(DV+64):GOSUB9450:GOSUB8500:GOSUB9470
                                                                                                                                                                                     8540 IF HIHH2 Ø THEN 8570
8550 PRINT"dn >> sp ERROR STATE-PRESS KEY TO FORCE"
8555 PRINT"NOTE: MAKE NRFD, NDAC TRUE"
 7040 B$=""
7050 GOSUB 8000:IF FNF(D1)=13THEN7070
7060 B$=B$+CHR$(FNF(D1)):GOTO7050
7070 GOSUB8000:REM LF BUCKET
7080 PRINT"dn dn MESSAGE IS: sp"B$
                                                                                                                                                                                     8560 GETA$; IFA$=""THEN8560
                                                                                                                                                                                     8570 GOSUB9050
 7090 RETURN
                                                                                                                                                                                     8580 PRINT"dn DATA ON LINE: "FNF(D2)CHR$(FNF(D2))
```

address of a memory location in decimal. If you press SPACE, the address will be erased, and a new number can be entered. Pressing number keys enters a new address, and a reverse-field cursor appears.

When a cursor isn't on the screen, pressing RETURN will move the marker to the next part of the box. (The second part in the box indicates the bit numbers and is skipped by the marker.)

The third part of the box displays a front panel made of solid or hollow "balls" (or "LEDs"). This shows the eight bits of the byte under investigation. The numbers above the "LEDs" indicate the bit numbers, 7 the MSB and 0 the LSB. To change the byte, enter 0 or 1 (or Shift-Q and Shift-W), and the cursor will appear. Pressing RETURN enters the value.

The fourth part of the box is the value of the byte in decimal and is entered in the same way as the address.

If you press RETURN several times, the marker rotates through the three accessible parts of the box. To recall how to enter a value, press the letter H, which clears the screen and provides instructions.

The Memory Monitor eased the tedium and frustration of

checking the PEEKs and POKEs used in the IEEE 488 memory locations. I have made Memory Monitor simple to use, and I consider it a good example of user-oriented programming.

Doing It the Hard Way

With direct access to the PET's IEEE 488 lines, you can use PEEK and POKE to operate an IEEE instrument "by hand." This is probably more difficult than using the IEEE Blinkin Lites box to communicate switch by switch because it takes more keystrokes to change a bit with POKE.

The next step is to write a BASIC program that performs the required IEEE 488 operations directly. Though the PET has these "built in," there are a few advantages to doing the whole thing in BASIC.

Everything goes slowly. As events happen, there is a chance of seeing them as they go by.

BASIC is accessible. If the

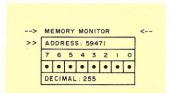


Fig. 9. Listing 1's initial display.

```
8590 print"dn WAITING FOR NRFD FALSE'
8600 GETA$::FA$<>""THENPRINT"--FORCE
8610 GOSUB9300:1FH3=1THEN8600
8620 GOSUB9150
8630 PRINT"dn sp DAV TRUE"
8640 PRINT"WAITING FOR NDAC FALSE"
8650 GETAS:|FASC>""THEN8670
8670 GOSUB9170
8680 PRINT"dn sp DAV FALSE"
8690 RETURN
9000 POKEA2,N8:D1=PEEK(A1):RETURN
9050 POKEA2,D2:RETURN
9100 H1=1:IFPEEK(A6)ANDM7THENH1=Ø
9110 RETURN
9150 POKEA4. PEFK (A4) ANDN 3: RETURN
9170 POKEA4, PEEK (A4) ORM3: RETURN
9200 H2=1: IFPEEK (A6) ANDMØTHENH2=Ø
9250 POKEA3, PEEK (A3) ANDN3: RETURN
9270 POKEA3, PEEK (A3) ORM3: RETURN
9300 H3=1: IFPEEK (A6) ANDM6THENH3=Ø
9350 POKEA6. PEEK (A6) ANDN1: RETURN
9370 POKEA6. PEEK (A6) ORM1 : RETURN
9400 PRINT"NO ATN LEVEL":STOP
9430 H4=0:IFPEEK(A3)ANDM7THENH4=1
9440 ZZ=PEEK(A1):RETURN
9450 POKEA6, PEEK (A6) ANDN2: RETURN
9470 POKEA6, PEEK (A6) ORM2: RETURN
9500 H5=1:IFPEEK(A5)ANDM6THENH5=Ø
9510 RETURN
9550 POKEA7, PEEK (A7) ANDN3: RETURN
9570 POKEA7, PEEK (A7) ORM3: RETURN
9600 REM SRO NOT OUTPUT
9630 H6=Ø:IFPEEK(A4)ANDM7THENH6=1
9640 ZZ=PEEK(A2):RETURN
```

PET or your instrument decides that the sky's the limit, pressing the STOP key can illuminate where the difficulties lie. The PET's built-in IEEE 488 services are mostly invisible, and there's often no way to find out why something went wrong.

Everything is under control. It is simple enough to display every step with suitable messages to the screen. If necessary, you can insert a GET loop to make the PET wait until a key

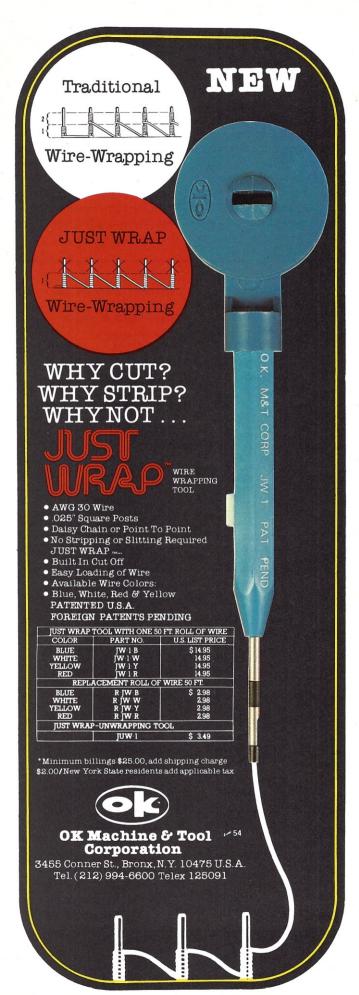
is pressed before proceeding.

Changes are easy.

It's an educational experience—those who must learn the "nuts and bolts" of the IEEE bus will find a BASIC emulator useful.

I constructed the BASIC 488 program (see Listing 2) to provide the following essential services: put the PEEK and POKE values into variable form for reasonably fast execution and to simplify debugging with direct

	OUTINE 1500		Ini	tialization (N	Aust be	done first	t)
	OUTINE 7000		Ge	t Message	as B\$, I	Requires D	
SUBR	OUTINE 7500		Pu	t Message (C\$, Rec	uires DV	
	OUTINE 8000 OUTINE 8500			ten Handsh Ik Handshal			
SUBR	OUTINES 900	Off1960	O IE	E Lines Pri	mitives		
	9000 9050			ad DIO as Dite DIO as D			
	9100		Re	ad DAV as I	- 11		
	9150			DAV TRUE			
	9170			DAV FALS			
	9200			ad NDAC as			
	9250			NDAC TRU			
	9270			NDAC FAL			
	9300			ad NRFD as			
	9350			NRFD TRU	1000		
	9370		Se	NRFD FAL	.SE		
	9400			p for ATN			
	9430			eck ATN as		changed)	
	9450			ATN TRUE			
	9470			ATN FALS			
	9500			ad EOI as H		The state of the s	
	9550			EOI TRUE			
	9570		Se	EOI FALSE	(Scree	en returns)	
	9630		Ch	eck SRQ as	H6 (If	changed)	
ariables:							
PEEK/	POKE ADDRE	ESSES		ORIGINA	L VAL	JES	
	A1	59	9424	01		255	
	A2		9426	02		255	
	A3		9425	03		60	
			9427	04		60	
	A4			04		00	
	A4 A5		9408	05		249	
		59	9408 9456				
	A5	59 59		05		249	
vlasks:	A5 A6	59 59	9456	05 06		249 255	
Masks: M0	A5 A6	59 59	9456 9409	05 06	254	249 255	
	A5 A6 A7	59 59	9456 9409 N0	05 06 07		249 255	
МО	A5 A6 A7	59 59 59	9456 9409 N0	05 06 07	253	249 255	
M0 M1	A5 A6 A7 0000 0001 0000 0010	59 59 59	NO N1 N2	05 06 07 1111 1110 1111 1101	253 251	249 255	
M0 M1 M2	A5 A6 A7 0000 0001 0000 0010 0000 0100	59 59 59 1 2 4	N0 N1 N2 N3	05 06 07 1111 1110 1111 1011	253 251 247	249 255	
M0 M1 M2 M3	A5 A6 A7 0000 0001 0000 0010 0000 0100 0000 1000	59 59 59 1 2 4 8 16	N0 N1 N2 N3	05 06 07 1111 1110 1111 1011 1111 0111	253 251 247 239	249 255	
M0 M1 M2 M3 M4	A5 A6 A7 0000 0001 0000 0010 0000 0100 0000 1000 0001 0000	59 59 59 1 2 4 8 16 32	N0 N1 N2 N3 N4	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111	253 251 247 239 223	249 255	
M0 M1 M2 M3 M4 M5	A5 A6 A7 0000 0001 0000 0110 0000 0100 0000 1000 0001 0000 0010 0000	59 59 59 1 2 4 8 16 32 64	N0 N1 N2 N3 N4 N5	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111	253 251 247 239 223 191	249 255	
M0 M1 M2 M3 M4 M5	A5 A6 A7 0000 0001 0000 0100 0000 1000 0000 1000 0001 0000 0010 0000 0100 0000	59 59 59 1 2 4 8 16 32 64 128	N0 N1 N2 N3 N4 N5 N6	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111 1011 1111	253 251 247 239 223 191 127	249 255	
M0 M1 M2 M3 M4 M5 M6 M7	A5 A6 A7 0000 0001 0000 0110 0000 1000 0001 0000 0010 0000 0100 0000 1000 0000	59 59 59 1 2 4 8 16 32 64 128	NO N1 N2 N3 N4 N5 N6 N7	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111 1011 1111	253 251 247 239 223 191 127	249 255	
M0 M1 M2 M3 M4 M5 M6 M7	A5 A6 A7 0000 0001 0000 0110 0000 1000 0001 0000 0010 0000 0100 0000 1000 0000	59 59 59 1 2 4 8 16 32 64 128	NO N1 N2 N3 N4 N5 N6 N7 N8	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111 1011 1111	253 251 247 239 223 191 127	249 255	
M0 M1 M2 M3 M4 M5 M6	A5 A6 A7 0000 0001 0000 0110 0000 1000 0001 0000 0010 0000 0100 0000 1000 0000	59 59 59 1 2 4 8 16 32 64 128	NO N1 N2 N3 N4 N5 N6 N7 N8	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111 1011 1111	253 251 247 239 223 191 127	249 255	
M0 M1 M2 M3 M4 M5 M6 M7	A5 A6 A7 0000 0001 0000 0110 0000 1000 0001 0000 0010 0000 0100 0000 1000 0000 1000 0000 s:	59 59 59 1 2 4 8 16 32 64 128	9456 9409 N0 N1 N2 N3 N4 N5 N6 N7 N8	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111 1011 1111 1111 1111	253 251 247 239 223 191 127	249 255	
M0 M1 M2 M3 M4 M5 M6 M7 Miscellaneous	A5 A6 A7 0000 0001 0000 0110 0000 1000 0001 0000 0010 0000 0100 0000 1000 0000 S:	59 59 59 1 2 4 8 16 32 64 128 Address	9456 9409 N0 N1 N2 N3 N4 N5 N6 N7 N8	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111 1011 1111 1111 1111	253 251 247 239 223 191 127	249 255	
M0 M1 M2 M3 M4 M5 M6 M7	A5 A6 A7 0000 0001 0000 0110 0000 1000 0001 0000 0010 0000 0100 0000 1000 0000 1000 0000 s:	59 59 59 1 2 4 8 16 32 64 128 Address	9456 9409 N0 N1 N2 N3 N4 N5 N6 N7 N8	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111 1011 1111 1111 1111	253 251 247 239 223 191 127	249 255	
M0 M1 M2 M3 M4 M5 M6 M7 Miscellaneous	A5 A6 A7 0000 0001 0000 0110 0000 1000 0001 0000 0010 0000 0100 0000 1000 0000 S:	59 59 59 1 2 4 8 16 32 64 128 Address	9456 9409 N0 N1 N2 N3 N4 N5 N6 N7 N8	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111 1011 1111 1111 1111	253 251 247 239 223 191 127	249 255	
M0 M1 M2 M3 M4 M5 M6 M7 scellaneous	A5 A6 A7	59 59 59 1 2 4 8 16 32 64 128 Address	9456 9409 N0 N1 N2 N3 N4 N5 N6 N7 N8	05 06 07 1111 1110 1111 1011 1111 0111 1110 1111 1101 1111 1011 1111 1111 1111	253 251 247 239 223 191 127 255	249 255	



CLR GOSUB 1500:GOSUB 1900 Get everything ready . . . PRINT FNF(32 + 7) This is the value for D2 as a listen address. 216 **GOSUB 9450** Make ATN true. D2 = 216:GOSUB 8500 Send listen address via handshake TALK HANDSHAKE The PET responds with the step-by-step DAV FALSE output handshake and goes successfully DATA ON LINE: 39' through the entire process. WAITING FOR NRFD FALSE DAV TRUE WAITING FOR NDAC FALSE The HP Clock's "addressed" light turns on! DAV FALSE READY. **GOSUB 9470** Make ATN false R resets the clock PRINT FNF(ASC("R")) 173 D2 = 173:GOSUB 8500 Send 'R' as data And this handshakes through OK too. Example 1. My dialogue with the HP clock via BASIC 488.

D2 = 216:GOSUB9450:GOSUB8500:GOSUB9470:D2 = 173:GOSUB8500

Example 2. A one-line command for Example 1.

PRINT FNF(64 + 7) Find out D2 for talk address D2 = 184:GOSUB9450:GOSUB8500:GOSUB9470 The handshake goes through (.....)
FOR J = 1 TO 14:GOSUB 8000:NEXT (..... for 14 times)

Example 3. The dialogue for reading the clock.

commands; do most of the PEEKs and POKEs for line control as short subroutines; provide the listen and talk handshake sequences for one byte and display their progress; provide a way to send and receive strings to a device on the bus: set the program up as a skeleton onto which you can add specific programs to suit changing needs.

Table 4 indicates the subroutines and variables used in the BASIC 488 program. Load these subroutines and then add the code you need for your devices. Some devices, such as those by Commodore, may not follow the IEEE time standard, and the BA-SIC 488 program will not be fast enough to prevent time-outs.

I built the program from the bottom up, starting with subroutines 1500 and the series starting at 9000. Subroutine 1500 sets up the essential variables. A1-7 are the addresses of the PEEK/POKE locations; M0-M7 and N0-N8 are AND and OR

masks to extract bits 0-7 from a location (or to set the desired bits); 01-07 are the original values for addresses A1-A7. (POKE A1,01, for example, will restore location A1 to the PET's power-on value, which helps you to recover from disasters.)

The variables H1 to H6 are the sense values for the IEEE lines. For example, if H1 is 1, the DAV line is true. If H1 is zero, DAV is false.

When you enter BASIC 488, enter lines 1000-1620 and lines 9000-9640 first. Use the IEEE Blinkin Lites to check that the subroutines in the 9000 series function correctly. First, GOSUB 1000 in direct mode to set things up. Then, GOSUB to the section under test and look at the Blinkin Lites to see what happened. A PRINT H1 will inform you of the sensing subroutines' results. Be sure to thoroughly test the 9000 series first! Nothing else will work if these

If all else fails, refer to Tables

X\$ = "":FORJ = 1TO14:GOSUB8000:X\$ = X\$ + CHR\$(FNF(D1)):NEXT:PRINTX\$ 0101000520

Example 4. Putting the clock's message into X\$, and the contents of X\$.

1, 2 and 3 and try a few direct PEEKs and POKEs to ensure that the IEEE lines are functional.

Add lines 8000-8140 and lines 8500-8690, which you can check by attaching the 488 Blinkin Lites and carefully tracing through the handshake flowchart in Fig. 7. Again, it is essential to be sure these routines work correctly. An additional benefit is that you will learn the handshake sequence in detail.

Note that the data transferred, D1 or D2, must be complemented with the FNF function as it enters or leaves the IEEE bus. In some of the waiting loops, such as lines 8030-8050, a GET A\$ check is inserted. If the instrument hangs up, pressing a key will force the handshake to proceed, and a suitable message will appear on the screen. As the handshakes proceed, their progress is reported to the screen for your reference.

Next, add lines 7000-7570. These routines require a device address, DV, to function correctly. Subroutine 7000 will fetch a message from a device, and subroutine 7500 will send a message. The strings B\$ and C\$ are used to store the messages.

Most devices will send an EOI along with the last character of their messages. This will turn off the screen. In some cases, you will have to provide an EOI, which will again turn off the screen. To recover, enter:

GOSUB 9570 (and RETURN)

Another approach is to move the cursor down until the screen scrolls. A scroll turns the screen off, and then on. If you have a 16K PET, the screen will not blink.

Testing the last part via the IEEE Blinkin Lites is tedious. If you have an instrument available, try talking to it! Be sure you know exactly what your instrument expects and its responses!

Talking to the HP Clock via BASIC 488

Now that you have checked out BASIC 488 by hand, try it with a real live instrument! I connected the HP clock, loaded BASIC 488 and gave it a try (see Example 1). The clock's front panel shows the reset worked.

These commands can be

DV = 7:GOSUB7500 SEND MESSAGE MESSAGE:? R R for reset GET MESSAGE PRESS KEY TO START (.... A lot of Listen Handshakes) MESSAGE IS: 0101000158 Example 5. Resetting the clock.

compressed to one line (see Example 2).

Next, try to read the clock. Address the clock to talk, then read the 14-character message shown in Example 3. If you look at the line DATA: on the display for the Listen Handshake, you can barely see the clock's message. A different version (see Example 4) will pick up the message and leave it later. Below the Listen Handshake display appears the clock's message: 0101000520

The BASIC 488 program has two routines for sending and reading entire strings via the IEEE 488. Subroutine 7000 addresses device DV to talk and

```
IEEE Bus Handshake Routine
                                                                                                 Subroutine to Handle
  Main Program
                                                                                                 Handshake From Bus
                                                                                                 18BO A902 LDA #02
18B2 OD40E8 ORA E840
 1800 A200
                 LDX #00
                                    prepare index register
                                                                                                                                    set NRFD high
 1802 A9FB
                  I.DA #FR
                                    set ATN low
 1804 2D40E8 AND E840
1807 8D40E8 STA E840
180A A928 LDA #28
                                                                                                 1885 8D40E8 STA E840
1888 AD40E8 LDA E840
                                   MLA (28 for this device)
                                                                                                 18BB 2980
                                                                                                                  AND #80
                                                                                                 18BD DOF9 BNE 18B8
18BF AD20E8 LDA E820
18C2 49FF EOR #FF
                  STA O1
                                                                                                                                    jump back if not valid
180E 208018 JSR 1880
                                   handshake into bus
                                                                                                                                    get data byte from bus
1811 A908
1813 8501
                                                                                                                                    complement
store in $ 0002
                                                                                                 18C4 8502
18C6 A9FD
                 STA 01
1815 208018 JSR 1880
                                   handshake
                                                                                                                  LDA #FD
                                                                                                                                    set NRFD low
1818 A948 LDA ₹48
181A 8501 STA 01
181C 208018 JSR 1880
                                                                                                 18C8 2D40E8 AND E840
18CB 8D40E8 STA E840
                                                                                                18CB 8D3-6-1

18CE A908 LDA -0-1

18DO 0D21E8 ORA E821

18D3 8D21E8 STA E821

18D4 E840
                                   handshake
                                                                                                                                    set NDAC high
181F A9FD LDA #FD
1821 2D40E8 AND E840
                                   set NRFD low
(ready to receive data)
1824 8D40E8 STA E840
                                                                                                                                    DAV high ?
1827 A9F7 LDA #F7
1829 2D21E8 AND E821
                                                                                                 18D9 2980
18DB FOF9
                                                                                                                  AND 480
BEQ 18D6
                                    and NDAC low also
                                                                                                                                    jump back if not
182C 8D21E8 STA E821
                                                                                                 18DD A9F7
                                                                                                                  LDA #F7
                                                                                                                                     set NDAC low
182F A904 LDA #04
1831 OD40E8 ORA E840
1834 8D40E8 STA E840
                                                                                                 18DF 2D21E8 AND E821
18E2 8D21E8 STA E821
                                    set ATN high
                                                                                                 18E5 A9FF
                                                                                                                 LDA #FF
                                                                                                                                    25510 into bus
1837 AOO8 LDY #08
1839 20B018 JSR 18B0
                                   ready to count 8 bytes
handshake data from bus
                                                                                                        8D22E8 STA E822
                                                                                                                                    return to main
183C A502
                  T.DA O2
                                    result to A
183E 9D0119 STA 1901,X
                                   store in 1901+X
1841 E8
                  INK
1842 88
1843 DOF4
                                   jump if Y not zero
set ATN low
                 BNE 1839
1845 A9FB
                 LDA #FB
                                                                                                 IEEE Bus Handshake Routine
1847 2D40E8 AND E840
184A 8D40E8 STA E840
                                                                                                 Object Listing
184D A902
                                    set NRFD high
                                                                                                1800 A2 00 A9 FB 2D 40 E8 8D 1808 40 E8 A9 28 85 01 20 80 1810 18 A9 08 85 01 20 80 18 1818 A9 48 85 01 20 80 18 A9 1820 FD 2D 40 E8 8D 40 E8 A9
184F OD40E8 ORA E840
1852 8D40E8 STA E840
1855 A908 LDA #08
1857 OD21E8 ORA E821
                                    set NDAC high
185A 8D21E8 STA E821
                                                                                                 1828 F7 2D 21 E8 8D 21 E8 A9
185D A95F
185F 8501
                LDA #5F
                                   UNT
                                                                                                 1830 04 0D 40 E8 8D 40 E8 A0
1838 08 20 B0 18 A5 02 9D 01
                 STA O1
1861 208018 JSR 1880
                                   handshake to bus
                                                                                                 1840 19 E8 88 DO F4 A9 FB 2D
1864 A904 LDA ∜04
1866 OD40E8 ORA E840
                                    set ATN high
                                                                                                1848 40 E8 8D 40 E8 A9 02 OD
1850 40 E8 8D 40 E8 A9 08 OD
1858 21 E8 8D 21 E8 A9 5F 85
1869 SDACES STA ESAC
186C CE0019 DEC 1900
                                    decrease counter
                                                                                                 1860 01 20 80 18 A9 04 0D 40
1868 E8 8D 40 E8 CE 00 19 DO
                                   jump if not zero
return to BASIC program
186F DO91
                 BNE 1802
                                                                                                 1870 91 60 EA EA EA EA EA EA
1878 EA EA EA EA EA EA EA
                                                                                                 1878 EA EA EA EA EA EA EA
1880 AD 40 E8 29 40 FO F9
Subroutine to Handle
                                                                                                 1888 O1 49 FF 8D 22 E8 A9
1890 2D 23 E8 8D 23 E8 AD
Handshake Into Bus
1880 AD40E8 LDA E840
                                   NRFD ?
                                                                                                 1898 E8 29 O1 FO F9 A9 O8 OD
1883 2940
1885 FOF9
                 AND #40
BEQ 1880
                                                                                                 18AO 23 E8 8D 23 E8 A9 FF 8D
18A8 22 E8 60 EA EA EA EA EA
                                   jump back if not ready
1887 A501 LDA 01
1889 49FF EOR #FF
188B 8D22E8 STA E822
                                   ready: get data byte complement it
                                                                                                 18BO A9 O2 OD 40 E8 8D 40 E8
                                                                                                18B8 AD 40 E8 29 80 DO F9 AD
18CO 20 E8 49 FF 85 O2 A9 FD
                                   send to bus
                                                                                                18C8 2D 40 E8 8D 40 E8 A9 08
18D0 OD 21 E8 8D 21 E8 AD 40
188E A9F7
                I.DA SET
                                   set DAV low
1890 2D23E8 AND E823
1893 8D23E8 STA E823
                                                                                                 18D8 E8 29 80 FO F9 A9 F7
                                                                                                18EO 21 E8 8D 21 E8 A9 FF
18E8 22 E8 60
1896 AD40E8 LDA E840
                                   NDAC ?
1899 2901
189B FOF9
                AND #01
BEQ 1896
                                   jump back if not accepted
189D A908 LDA #08
189F OD23E8 ORA E823
                                   accepted; set DAV high
                                                                                                0001 data to go into bus
18A2 8D23E8 STA E823
18A5 A9FF LDA #FF
18A7 8D22E8 STA E822
                                   255 10 into bus
                                                                                                1900 counter for number of data transfers
18AA 60
                                   return to main
                                                                                                1901 start of results area
```

read a string. Subroutine 7500 addresses device DV to listen and sends a string. (Note: Routine 7000 reads a string until a carriage return is seen, and then reads one more character. This is because the HP clock ends messages with CR and LF. You might have to change this for your device.)

To reset the clock:

DV = 7:GOSUB 7500

The screen clears and asks for the message (see Example 5).

The Talk Handshake flashes on the screen twice, and the message sent is displayed below:

MESSAGE SENT: R

The program uses routine 7000 to read the time. Since DV is already set, we don't have to reassign DV = 7 again. See Example 5. Note that there are three spaces between the colon and the first zero. Two of these are from the HP clock, which starts all messages with two blanks.

The BASIC 488 program, though slow to operate, never times-out and lets you control the IEEE 488 bus. This is helpful when you debug a new IEEE device with your PET.

If you are an experienced 6502 programmer, it is simple to translate the BASIC 488 program into a set of machinelanguage routines. If you do so, I'd like a copy (tape and source). Listing 3 shows a copy of the IEEE handshakes in machine language. (From the PET User Notes, PO Box 371, Mont-

Program Listing Conventions

The PET's graphics and cursor control characters aren't easily duplicated for program listings, so the conventions described here will be used instead.

If a letter or numeral (or any character) is underlined, it means the corresponding graphics character is to be used. (A is the spade symbol on the PET.)

Lowercase letters indicate PET special functions:

Clear Screen hm Home Cursor Cursor Left Cursor Right lft -Cursor Up Cursor Down up dn rvs RVS field on off RVS field off RETURN key SPACE key sp

Sp in a line indicates leading or more-than-one blank. For example, dn/sp/sp/HELLO THERE means Cursor Down space HELLO space THERE.

gomeryville, PA 18936, Vol. 1, Issue 7, (Nov.-Dec. '78), p. 8. This is a reprint from the Commodore

PET Users Club of England.) The PET handles the IEEE 488 as a file. Part 2 will cover this.

Two IEEE 488 Instruments

The two instruments described here are typical in the way they are controlled via the IEEE 488 bus. Most instruments are controlled by sending and receiving ASCII characters, which are mnemonics of the function being controlled. For example, the HP clock uses the letter D to increment its days' counter. Numbers are usually sent as ASCII strings—in the same way that PRINT provides an ASCII string of digits to a terminal. CR and LF usually indicate a message's end.

Some instruments will use more difficult formats. Two popular forms are BCD, in which two digits per byte are sent, and pure binary, where the value 0-255 is sent. Be sure you know the exact formats used by your instruments! Most instruments are unforgiving of bad data; and the responses range from ignoring meaningless characters to the instrument's unaddressing and leaving the bus. Check your instrument's manual!

The HP 59309A Digital Clock

The HP clock is almost the simplest instrument that uses the IEEE 488 bus. Your options are to either set the time or read the

When the clock is addressed to talk, it will provide a string of characters with the time in the following format:

(sp or ?) sp NNDDHHMMSS cr If

The first character is a space or a question mark. If the clock hasn't been set since the last power-off, the question mark will indicate this. The next two digits indicate the month, from 01 to 12. Then comes the day of the month, 01 to 31. (The clock keeps track of the days in each month correctly and has a leap-year switch). Then the hours (00 to 23), minutes and seconds are sent. The carriage return and line feed indicate the end of the message.

Inside the clock are switches that provide variations of the format-colons or commas can either separate the fields, i.e., NN:DD:HH:MM:SS, or simply send the 24-hour time.

When the clock is addressed to listen, eight ASCII characters are used for control:

P-Stop the clock

T-Start the clock

R-Reset the 01:01:00:00:00

S-Each S will increment the Seconds counter

M-Increment Minutes counter

H-Increment Hours counter

D-Increment Days counter

C—Note time, send it when addressed to talk.

For example, the following string will reset the clock to Jan 5, 8:07:12 AM.

PRDDDDHHHHHHHHHMMMMMMSSSSSSSSSSST

The T at the end restarts the clock.

The HP 8165A Programmable Signal Source

This is a "cadillac" 488 instrument—the front panel of this machine has 41 buttons for selection of modes and a 12-button number pad for entering times, and frequencies. This works out to 35 different command formats for setting up parameters and switch settings and nine commands for telling the controller the machine's setting or starting a sequence of actions. Some of the formats include:

F1—Select Sine Wave

F2-Select Triangle Wave

F3—Select Square Wave

FRQ f MZ—Select frequency in MHz. f is a number from 1 to 9999.

FRQ f MZ-Same for Hz

FRQ f KHZ-Same for kHz

SET:—Report all parameters currently operating when addressed to talk.

SET: n—Report setting in memory # n (0-9)

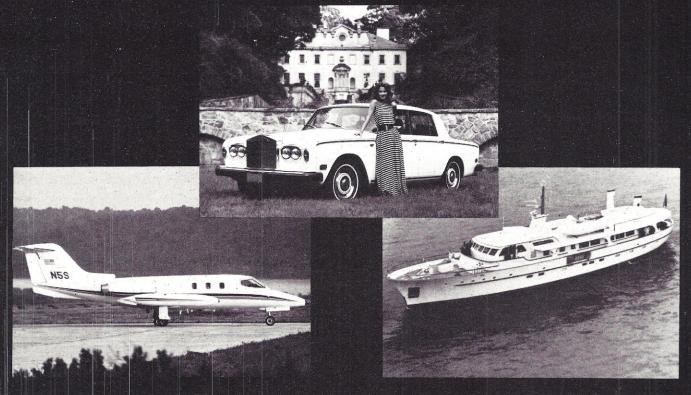
The 8165 can store up to ten complete settings in its memories, so the SET commands permit the controller to find out what's in the 8165.

An instrument of this complexity is usually programmed with a set of special-purpose programs as needed. Writing a generalpurpose BASIC program would be both tedious and wasteful. My experience is that the hardest part is to get the PET and the instrument to communicate. Once that is accomplished, the rest is

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Read all about it: a new computer, new floppies, new software!

Robert W. Baker 15 Windsor Dr. Atco, NJ 08004

Commodore has announced several new products as part of their PET/CBM line:

- Model 8032 CBM computer—an 80-column CBM with a 12-inch CRT; a new screen editor, version 4.1; and a new disk BASIC, BASIC 4.0.
- Model 8050 dual drive floppy disk—with increased storage capacity.
- Word Pro IV—for the 80-column 8032 CBM.
- ROM upgrade for the 2040 disk operating system—DOS 2.0 to support the new disk BASIC.
- ROM upgrade for the 16 and 32K CBMs to install disk BASIC.

In addition, a CBM modem interface was mentioned recently in one of the trade jour-

Acknowledgement

Special thanks to Larry Perry in Commodore Marketing for the equipment and information he provided for the preparation of this article.

nals and should be available later this year.

As the author of *Microcomputing's* PET-pourri column, I was fortunate to obtain an early model 8032 CBM from Commodore before writing this article. Although I've only been using the unit for several days, I am impressed. I haven't been able to try the 8050 disk yet. The following information on the 8032 and the new operating software should be enough to whet your appetite.

The 80-Column 8032 CBM

The 8032 CBM is similar in outside appearance to the former 32K business model CBM. A slight change in the cabinet design tilted the display slightly and changed the keyboard angle. The overall height of the 8032 with its 12-inch CRT is only one inch higher than the older CBM with its 9-inch CRT. I prefer the more comfortable lower keyboard angle.

Besides changing the lower cabinet, Commodore also changed the CRT enclosure to allow much easier access to the CRT controller board. By unscrewing only two screws, you can remove the entire CRT enclosure in one piece giving full access to the printed circuit board.

Internally, the main logic board has been changed slightly, and the metal arm to hold the cabinet open has been moved to the

front of the unit. As part of the new logic board layout, the second cassette interface has been moved to the back right side of the PC board. This makes the interface accessible through the side opening of the cabinet where the memory expansion interface was located on the original 8K PET.

As a side effect of this change, the internal expansion connectors are no longer in line with each other. Considering there have been few, if any, products that used these connectors, this change should not cause much concern. The rear cassette interface, user port and IEEE bus connections are still where they always have been.

The CRT controller board has undergone a major change and now has many fewer components. Commodore is now using a 6845 single chip CRT controller, which greatly reduces the time to display a line on the CRT. After doing some simple timing tests, I found up to a two-to-one difference between the older PETs and the new 8032. The 6845 also has many additional features that can be accessed directly via machine language.

The 8032 has the same character sets as the previous CBMs, selected by the familiar POKE 59468,xx command or new control characters. However, the CRT controller now adds two blank rows of dots between

BELL:

Sounds the internal bell for 1/4 second.

CHR\$(7)

DEL LINE:

Deletes a full line from the screen, which scrolls up from the point of deletion.

ERASE BEGIN

CHR\$(150)

Blanks all characters from the beginning of the line to the current cursor position. The characters do not move over; spaces are inserted in the blanked portion of the line.

ERASE END:

CHR\$(22)

Blanks all characters from the current cursor position to the end of the line. No characters are moved; spaces are left in the blanked portion of the line.

GRAPHIC:

CHR\$(142)

Has the same effect as poking 59468 with 12 to select the graphics character set. It also reduces the dot spacing between lines to zero for contiguous graphic characters. Poking 59468 will not affect the dot spacing between lines!

NSERT LINE

HR\$(149

Inserts a line on the screen by moving all characters below the cursor line, down one line. The bottom line will scroll off the screen and be lost.

SCROLL DOWN

HR\$(153)

Scrolls all lines down one line leaving a blank line at the top of the screen or at the top of the scroll window.

SCROLL UP:

CHR\$(25)

Scrolls all lines up one line leaving a blank line at the bottom of the screen or at the top of the scroll window.

SET BOTTOM

CHR\$(143)

Sets the current cursor position as the bottom right corner of the scrolling window.

SET TOP

CHR\$(15)

Sets the current cursor position as the top left corner of the scrolling window.

TEXT: CHR\$(14)

Has the same effect as poking 59468 with 14 to select the upper/lowercase character set. It also increases the dot spacing between lines to two for better viewing of text. Poking 59468 will not affect the dot spacing between lines!

Table 1. Screen editor control functions will execute the indicated function whenever included as part of a BASIC text string that is being displayed. Each function can be entered as either a control character or by the CHR\$(xxx) command.

lines of text when in the upper/lowercase mode for increased visibility.

When in the graphics mode, there are no blank rows of dots between characters to allow true graphics. Display memory still starts at location 32768, but is now 2000 characters long. Programs written for a 40-column CBM that poke display memory will not operate correctly on the 8032.

One other change to the CBM hardware is the addition of an internal "bell." A bell-like sound will be created by software as a sequence of several notes lasting about one-quarter second. The bell is used as an end-of-line warning, such as the bell on a typewriter. It will normally sound in column 75 as the cursor moves to the right through that position. The bell will also be accessible to the software via the ASCII bell code, CHR\$(7), in BASIC print commands. The sample unit I've been using doesn't have a bell, but it will be included in the final production units.

In addition to the hardware and mechanical changes, the ROM operating system has been changed. The 8032 CBM includes a new version of the screen editor with many new functions and features. A new disk BASIC includes many of the commands formerly provided by the DOS program (sometimes called the Wedge) loaded

from floppy disk.

However, the new BASIC requires a corresponding ROM upgrade in the 2040 disk. The new disk ROMs will also provide several new functions within the disk system, but a new disk format is used. Let's take a look at the new CBM operating system and its improvements before looking at the new disk operating system, DOS 2.0.

8032 Screen Editor

The new version of the screen editor, ver-

sion 4.1, greatly increases the capabilities of the CBM display. A group of new "control functions" is defined in Table 1. You can request these functions by printing the appropriate control character representing the desired function. These controls let you sound a bell, scroll the display up or down, erase or insert lines, blank out the beginning or end of a line or select the desired character set without poking 59468. Two of the controls, in particular, provide a versatile feature called a "scrolling window."

Normally, the scrolling window consists of the entire screen, 80 columns by 25 lines, and a program can print to any area of the screen. By using the set top and set bottom functions, a scrolling window can be defined as any smaller portion of the entire display area. The scrolling window is defined by positioning the cursor to the upper left corner of the area and printing a set top control character. Then the cursor is positioned at the lower right limit of the scrolling window, and the set bottom control character is printed.

When a scrolling window is defined, the program cannot print outside of the defined area. In addition, when the keyboard home key is pressed, the cursor is returned to the upper left corner of the scrolling window.

The 8032 CBM also has a tab key that will position the cursor at the next defined tab position or at the end of the line if no tabs are defined. If a narrower scrolling window is defined, the cursor will not be advanced past the last column of the scrolling window. The shifted tab key (tab set) is used to set or clear tab stops at the current cursor position.

Remember that the tab and tab set characters can be printed just like any other cursor control character. Even though you shouldn't ever use them at all, you can set up to 80 tabs on the 8032. That's equivalent to setting a tab in every column!

On the 8032, pressing the new ESC key removes the screen editor from the insert or

- 1. IEEE devices that return a status of one to an INPUT statement would cause the interpreter to hang.
- 2. The 41st or 81st GET on a line returned garbage. The 256th GET returned the first character of the same line.
- 3. While key-entering on the last line of the screen (in response to an INPUT statement), the auto scroll up process appended the INPUT statement prompt message to the data read.
- 4. The 64 millisecond IEEE time-out would result in a status error when a slow device such as a plotter was addressed. Disk BASIC now allows an optional disable of the IEEE time-out by poking 1020 with 0.
- 5. The software updated the screen display during vertical retrace time. However, the dynamic video RAM on the newer PETs can be updated during non-vertical retrace times without glitching the vertical retrace.
- 6. The TI\$ function in the business keyboard version lost time when the screen scrolled. TI\$ is now accurate.
- 7. Inputting more than 80 characters without a RETURN caused a system crash. Disk BASIC generates a ?STRING TOO LONG ERROR message.

Table 2. Disk BASIC enhancements and corrections to correct errors in version 2 BASIC, in addition to those mentioned in the text.

quote modes. Suppose you're typing the text for a BASIC print statement following the quote and discover a mistake further back in the line. On the older model CBMs you would have to delete all the characters back to the one in error, or type another quote to exit quote mode and allow cursor controls.

On the 8032 you simply type ESC to exit quote mode and allow the cursor controls. You then go back and correct the character in error. After repositioning, you can continue the line of text. However, you cannot enter a control key now, since you are not in quote mode.

This feature also allows you to enter control characters without using the CHR\$(xxx) command. Any characters entered in reverse field are turned into control characters in the string by BASIC. Thus, typing quote-ESC-RVS-g enters a control-G or bell code (07). The ESC key allows the RVS key to function instead of being entered in the string.

One other keyboard control that's been changed is the run key, which now enters a DLOAD-RETURN-RUN-RETURN sequence. This command sequence will load and run the first program found on the floppy disk in drive #0 on the 2040. You can, however, still load programs from cassette tape by simply typing the former LOAD command.

Disk BASIC

The first Commodore BASIC 1.0 was released in August 1977 for the PET 2001-8 computer. Version 2.0, released in July 1978, added a machine-language monitor and corrected the bugs of version 1.0. In May of 1979, version 3.0 was completed but never released for production. This version was intended to enhance the speed of string processing.

The new version 4.0 of Commodore PET BASIC, referred to as disk BASIC, includes all enhancements of the previous releases plus several new improvements as shown in Table 2. In addition, the 2040 disk commands have been integrated into the BASIC language, and a new random access file structure has been implemented.

Disk BASIC is the standard BASIC in the new 8032 CBM and can also be added as a ROM upgrade to the older CBMs. It does, however, require a corresponding new ROM set for the 2040 floppy disk system, DOS 2.0.

One enhancement contained in this latest ROM set is improved performance of string garbage collection. Garbage strings are any strings that occupy memory space but are no longer referenced by BASIC. To allocate a new string, the string storage must occasionally be compressed by eliminating these garbage strings.

In version 2 of the PET BASIC ROMs, the

algorithm to compress this space is extremely slow, often requiring several minutes to complete. To the user, the PET appears dead with no response from the keyboard or the stop key. Disk BASIC uses a new, much faster, algorithm that requires less than a second, even in the worst case.

The 14 new disk commands are shown in Table 3 with a brief description of each command. The parameters for each disk command are not order dependent, e.g., the file name, drive number and unit number can be

two disk status variables, DS and DS\$, have been defined. These reserved variables cannot be assigned a value by the user or a BASIC program. Whenever they are referenced in a print statement or the right-hand side of an expression, the disk command channel will be queried and the updated values assigned. The operating system will keep a flag to prevent rereading these values if a subsequent disk operation has not been performed.

With Disk BASIC and the corresponding

DOPEN - opens a disk file in the mode specified.

DCLOSE - can close all files currently open on a disk unit or only the logical file specified.

RECORD — is executed directly before GET#, INPUT# or PRINT# to position the disk at the desired record when using random access files. If this command is not executed, then the position accessed will be the next record directly after the last referenced record. The relative record number must be specified between 1 and 65535. An optional character position within a record can be specified between 1 and 254.

HEADER – formats the disk specified, when a disk ID number is specified. Otherwise, the directory is cleared and a new name is assigned to the disk. In direct mode, BASIC prints the following prompt and begins to flash the cursor:

ARE YOU SURE?

The command will not execute without a Y-RETURN or YES-RETURN response from the user.

COLLECT—frees up allocated space of improperly closed files on the disk and deletes their references from the directory. The block allocation map (BAM) stored on the disk is also verified.

BACKUP—duplicates a disk complete with disk name, ID, file layout and contents. It can only be used on version 2-formatted diskettes.

COPY—will only function on drives within a single floppy disk unit. It can create a copy of a file within the same drive or on the other drive in the unit. Copy without file names copies all files from one disk to another without altering files that already exist. Any files that have common names will cause a #63 error when copying all files.

CONCAT-concatenates two disk files.

DSAVE-saves a BASIC text file on disk.

DLOAD—loads a BASIC text file from disk.

DIRECTORY—displays the directory of a diskette. A printer can be addressed by CMD so that this command will produce a hard-copy directory listing. If a specific drive number is given, DOS 2.1 will initialize the drive.

RENAME—changes the name of a file on diskette.

SCRATCH—deletes a file from the disk directory, effectively deleting the file. The ARE YOU SURE? prompt will be given in direct mode as with the HEADER command. Any open files cannot be scratched.

APPEND—similar to a DOPEN command, except it applies only to sequential files. The 2040 write pointers are positioned to the next character position beyond the end of file. Additional data may then be written and the file re-closed.

Table 3. Disk BASIC disk commands.

specified in any order. File names may be in quotes or represented as a string variable. Drive numbers are indicated by the letter D, followed by 0 or 1. The default drive number is generally 0 but may be the last user-specified drive number.

The unit number (IEEE bus address) is optional on nearly all commands and defaults to 8. A user-specified unit is indicated by the letter U, followed by an integer between 4 and 31. Variables or expressions to be evaluated in disk command parameter lists must be enclosed in parentheses, e.g., U(D) or U(2 + B). The second cassette cannot be used simultaneously with the new PET disk commands.

With the addition of the disk commands,

DOS 2.0, you no longer have to bother with the disk error and control channel, channel 15. All error information is returned automatically simply by referencing the disk status variables.

For added convenience when writing sequential disk files, the PRINT# command has been modified in Disk BASIC. A PRINT# command will no longer transmit a line feed, CHR\$(10), after a carriage return if the logical address is less than 128. Thus, you no longer have to write:

PRINT#8,A\$;CHR\$(13);

Instead, you simply write

PRINT#8,A\$

If needed, all logical addresses greater than 128 will still send a carriage return and line feed at the end of each line, just as before.

Companion Disk Operating System

When upgrading to disk BASIC, you must install a corresponding ROM upgrade in the 2040 disk system. This ROM upgrade for the 2040 floppy-disk system can, however, still be used with the older version BASIC without any problems, except the lack of disk support directly within BASIC. The new disk operating system, DOS 2.0, has many changes besides the addition of true random access disk files. Before examining the new random access file structure, I will discuss the other changes made to DOS 1.2.

The most significant change is in the actual disk format, where a change was made to improve reliability in read and write operations. Diskettes created by either version 1 or 2 can be read by DOS 2.0, but only diskettes formatted by DOS 2.0 can be written by DOS 2.0. Thus, you must convert all diskettes to the new format if you intend writing to the diskette or want to back up version 1 diskettes with DOS 2.

The new disk format contains one less sector on tracks 18 through 24. This limits the number of directory entries to 144 and removes six data blocks from the diskette. Since the duplicate (BACKUP) command is a block-for-block copy, version 1 diskettes cannot be backed up with the BACKUP command on DOS 2.0. A new disk-to-disk copy command has been provided as a built-in utility for converting to the new format, as well as for general backup operations.

The following commands cannot be used with the old 2040-formatted diskettes (DOS 1.2):

DOPEN (write operations) HEADER (without IZZ)

COLLECT

BACKUP

COPY (writing new files)

CONCAT

DSAVE

RENAME

SCRATCH

APPEND

These commands can be used:

INITIALIZE

COPY (reading files)

DLOAD

DIRECTORY

For added convenience, the DOS version and format type will be indicated in the directory heading whenever the DIRECTORY command is issued. When 2A is displayed, it indicates that version 2 DOS formatted the diskette with 2040 format (Shugart 390 drives). Future format types will be indicated by different prefix letters other than A. When 1 appears in the directory, the diskette has the format associated

with version 1 DOS.

The version 1 DOS will not generate an error if a write operation is attempted on an A-formatted diskette. However, the headers will be disturbed, and successive operations will cause errors. If a write operation is attempted on an old 2040-formatted diskette by DOS 2.0, a 73 error code will be generated: 73,CBM DOS V2, track, sector.

Another major change incorporated into DOS 2.0 is an auto-initialization function. DOS 2.0 will manage the diskette initialization process prior to any file command or OPEN file sequence. The DOS compares the diskette ID from a header on the directory track against a master copy in memory. If they do not match, an initialization process will be invoked. This applies only to functions that involve directory searches. This new feature eliminates the initialize command required by DOS 1.2 every time you insert a diskette.

However, it is now important to assign a unique ID to each diskette. The auto-initialization function depends on a change of ID to detect a change of diskette. The original initialization command is still supported by DOS 2.0 (but not by Disk BASIC) for current software and explicit initialization. If required, the auto-initialization function can be switched off by:

OPEN 1.8.15

PRINT#1, "M-W" CHR\$(243);CHR\$(16);CHR\$(1);CHR\$(1)

The other areas changed involve disk and file copying functions. Disk copying via the BACKUP command is now faster and more reliable. An error counter has been added to abort the function if a predetermined number of errors are reached. In addition, the back-up process now takes about 2 minutes and 15 seconds, as opposed to 6 or 7 minutes in the old system.

The file copy command has been expanded to include a copy of all files from one disk to another disk, as previously provided by a BASIC utility program. Other special copy commands have been added to concatenate or append files as desired.

A few errors have been found and documented in the new DOS 2.0. The most serious or most often seen errors include:

- •The save-replace problem originally found in DOS 1.2 still exists.
- •Scratch will not remove a file recently used but properly closed. The system may have to be reset before allowing the file to be scratched.
- •A bad status (ST) may be returned when DS\$ is accessed following a disk operation.
- •Pattern matching with trailing question marks does not function properly. The compare routine in the file-name search matches characters on a character-by-character basis. If the file name is smaller in length than the length of the pattern without the trailing question marks, a match is made

improperly. For example, A??? will match A, AA, AAA and AAAA, but not AAAAA.

- •Relative files cannot be copied with the COPY command.
- •The relative record pointer may not be handled properly in all cases following a PRINT#. A RECORD command should be issued before each PRINT# command.

Overall, the entire disk operating system has been greatly enhanced and improved over the previous version, even without the addition of random access files.

Relative Record File System

Ever since the first 2040 floppy disks were released, many people have complained about the lack of a good random access file structure. This shortcoming of the early systems made many applications much more complex than necessary. As a result, many people avoided using random access files where they really would have enhanced a particular program package.

The new DOS 2.0 has taken care of that by including an advanced random access file structure with all the necessary support functions. The overall relative record file system is much like those of many larger systems and easy to use.

Relative files involve a direct access method that allows the programmer to position to any record relative to the beginning of the file. Record sizes are fixed in length and may range from 1 to 254 bytes per record. Record numbers are limited to the capacity of the disk but may not exceed 65535.

The two main components of a relative file are the side sector chain of blocks and the data block chain. Both are linked together through forward pointers similar to a sequential file.

Data block pointers in the side sectors allow the DOS to move from one record to another within two disk reads. The side sector also contains a table of pointers to all of the other side sectors within the file. To move from one side sector to the other, the pointer is referenced and the corresponding track and sector is read. Once the proper side sector is read into memory, the data block pointer is referenced, and that track and sector is used to read in the actual data block containing the record.

A file may contain up to six side sectors, each of which may contain pointers to 120 data blocks. Therefore, the largest file on the 2040 DOS 2.0 would be:

120 data block pointers per side sector

- × 6 side sectors
- × 254 bytes per data block
- = 182,880 bytes, which is greater than the current capacity of the 2040 disk format.

The side sectors do not contain record information, but contain the locations of the data blocks. The record size is used to compute the locations of the data blocks and



Model 8050 dual drive floppy disk from Commodore.

where the pointer is placed when a record number is given through the RECORD command

To open a relative record file for the first time, the DOS generates one data block and one side sector. For a record size of 10, 25 records will be generated automatically upon the opening using 250 bytes of the available 254 data bytes. Then you expand the file by a reference to the last record number you wish to generate through the RECORD command that prints it. Intermediate records from the current end to the referenced record number will be generated by the DOS. Any side sectors and all data blocks necessary to contain a file of this size will also be generated.

The relative channel requires three memory buffers from the system; whereas, sequential files only require two. Since there are only 12 buffers in the system, and two of these are used in directory searches and internal functions, only three relative channels can be open at one time. Any combination of sequential and relative record files can be open at one time as long as no more than ten buffers are required.

Every time the DOS positions to a record—either through the RECORD command or a previous I/O statement to a record—it performs a read-ahead function for further sequential action. This is transparent to the user, since the 2040 performs all these I/O functions independent of the main CPU.

In the case where a read-ahead record spans two data blocks (starts in one data block and ends in another data block), the DOS simply reads in the remaining part of the record, as well as any following records in the next data block. The records of most relative files will span across data blocks, since only record sizes of 1, 2, 127 and 254 divide evenly into the 254-byte size of a data block.

When a record is written into through the PRINT# statement, the data block is not immediately written out to the disk. It is only written to the disk when the DOS moves beyond the particular data block that the record resides in. This can occur through successive printing to sequential records or positioning to another record outside of that particular data block. This feature reduces the number of disk reads and writes and will improve time efficiency.

However, because of this feature, it is recommended that two channels not be open to a relative file at one time if either channel will be writing to the relative file. An update may be made in the channel's particular memory buffer area without causing a change on the disk file or the other channel's buffer area. There is no restriction if the channels are simply reading from the file. It may actually be advantageous for certain applications to have more than one channel open to a single relative file.

The relative file has also been designed so that you don't have to specify record numbers when printing to it. The relative file can be treated as a sequential file of certain record lengths. Whenever a write or read operation through an INPUT# or PRINT# statement is performed, the next reference record will be the sequential record. This feature can be used to simulate variable record size in a relative file by using a small record length such as ten and referring to the beginning of a variable record and N

number of records thereafter. Each of these groups could be referred to as a logical record.

The DOS terminates printing to a record by sending the EOI signal from the IEEE. This signal is generated on every PRINT# statement regardless of its form. Therefore, each relative record must be printed with a single PRINT# statement. If the PRINT# statement goes over the preset record size, error #51,RECORD OVERFLOW will be generated. The information will be truncated to the number of characters specified by the record size, and the DOS will position to the next record in sequence.

If the PRINT# statement contains fewer characters than the record size, the remaining positions within the record will be filled with nulls (0). If you need to store binary information, you will have to use a record terminator such as a carriage return, CHR\$(13), and increase the record size by one to accommodate the terminator.

When generating new data blocks for relative files, the requested record number is checked against the number of data blocks left on the diskette. When the resulting number of data blocks is greater than what is left on the diskette, error #52,FILE TOO LARGE is generated. This protects you from generating a file with an error and requiring them to scratch the file to recover the space.

Review

The introduction of the 8032 CBM could be the most significant move by Commodore to increase their share of the current small-systems market. The 8032 has all the proven features of the earlier PET/CBM models, plus a more common display size and an enhanced screen editor. If it's as reliable as previous models, it could easily become the most popular system in the near future.

In addition, if the preliminary documentation I've seen is any indication of what to expect with future products, the complaints about poor documentation from Commodore should quickly disappear. If you're ready to buy a new system, you should take a look at the 8032 when it becomes available in your area.

The only problem I see with the new 8032 CBM is with support software. For anyone to be able to support every PET/CBM model and operating system is almost impossible. Now, more than ever, you'll have to be certain that desired software will run on your particular system.

When ordering software, indicate as much information about your system as possible. Be sure to indicate the correct model and any ROM upgrades added since received. I hope someone will come up with an easy way to identify the various com-

binations that will be possible. Until that time, the more information supplied with an order, the better your chances the programs will run on your system.

Almost any program written for the older models must be modified to run on the 8032. Remember that Disk BASIC is a new ROM release. The routines in the ROM operating system and possibly low memory pointers have been changed again, just as in the last ROM release. In addition, the screen size is now twice as wide, and most programs will not handle the display properly, especially if you poke screen memory, rather than use BASIC PRINT statements.

If you already own a 16 or 32K PET/CBM, remember that you can upgrade to Disk BASIC by simply changing your ROMs. You won't have 80 characters per line, but you will have the new ROM operating system. However, you will have the same compatibility problems as new 8032 owners have, except for the differences caused by the 80-column display.

For example, Commodore's Word Pro 3 word-processing package and Eastern House Software's MAE assembler package will not run with Disk BASIC. It appears that owners of the 8K PETs will be guickly left behind. I don't believe that Disk BASIC will be available for the 8K PETs, but I haven't seen any final word on this.

Model 2040 floppy disk owners can also upgrade their ROM sets to take advantage of DOS 2.0 and its related features. You don't have to have Disk BASIC to use DOS 2.0, but I'm not sure if they will be available separately. Keep in mind that you will most likely have to recopy every diskette in the new disk format. This can be a major task if you have a number of disks.

In my case, it took almost a week to convert every disk to the new format. In the long run, however, I feel it was well worth it. I've had much fewer disk problems, and most disk operations seem to run faster. Once you change the ROMs, though, you can only read old-format disks.

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A File Sorting Program and Its Diary

This article's conclusion completes the sorting routine and further explores Apple DOS.

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ast month, in part 1 of the article, we began writing a file sorting program for the Apple II with disk drive. In the process, we examined the kind of planning that should precede the writing of this or any other relatively complex program. Our preparation completed, we began by writing the main or "top level" program and the first two subroutines. And we learned a fair amount about Apple DOS while doing so. In this concluding installment, we'll complete the sorting program and discover still more about Apple DOS.

Extracting the Key Fields

The subroutine that extracts the key fields from the input file

¹In the jargon of modern programming, writing these sketches is called using a program design language to design the program. There are formal program design languages which are used effectively in the design of large software systems. They are machine readable, and there are processors that read those designs and produce useful design reports and maintenance documentation. We are using an ad hoc, informal program design language for designing the routines in the file sort routine.

and records their original positions is the next programming task to be tackled. I approached this task by studying the file layout (see Fig. 5, part 1) and, as I did for the top level program, wrote a sketch of the subroutine¹ (see Example 1). I then used this sketch as an outline to write the subroutine in Fig. 1.

Two new aspects of the use of Apple DOS arise in this sub-routine. First consider line 2120. If HS = 3 and RG = 14 then the command:

READ CHAOTIC MESS,R3

will be issued when K = 0, and the command:

READ CHAOTIC MESS,R17

will be given when K=1. A READ command is used to tell Apple DOS that we wish to read (as opposed to, say, write) a given file. In the case of fixed-record-length files, the R parameter specifies which record is to be read next.

In Apple DOS the READ command does *not* cause any data to be read. It just informs Apple DOS that we are going to read data from the named file. Therefore, neither statement 2120 nor 2150 reads any data from the disk. The data is read by statements 2130 and 2160.

The way that Apple DOS works with both BASIC programming systems is that a READ command says, "From now until we turn off the read, all data that would come from the keyboard to an INPUT statement should come from the named file." This is the second important feature of Apple DOS.

Using the same trick that I used to check out the routines at lines 4000 and 6000 (i.e., setting D\$="%"), we can check out a program which reads data from a file without having any data filed on the disk! If the first character of the message part of a PRINT statement is not a control-D, then Apple DOS will ignore it. Therefore, if we assign the variable D\$ the value "%", what would have been

READ commands to DOS are just messages printed on the screen, and subsequent INPUT statements (which would have read data from the disk) are just INPUT statements that expect data from the keyboard! We can simulate the disk from the keyboard while we check out our programs.

This is a useful feature because it is often much easier to simply enter the kinds of data you want for debugging than it would be to make up files with all of the kinds of data needed for checkout. I used this technique to debug the subroutine at line 2000.

Before I go on to discuss the debugging run, I should point out one aspect of the READ command which is issued by the statement at line 2150. The last few characters (;",B";KF) cause a B parameter to be included in the READ command. If KF is currently 7, then the READ command will end with .B7.

The B parameter in a READ command tells DOS that some of the initial characters (or bytes) in the record are not to be input. For example, B7 means that we wish to start reading the record with byte number 7. I used this feature of the READ command to skip over the bytes in the record which precede the key field. Now let's examine the debugging run.

The results of the debugging run are shown in Fig. 2. With D\$

```
k = 0
fi = false
DO WHILE fi = false
READ record-number hs + (k*rg)
IF not end-of-file-string
THEN READ record-number hs + (k*rg) + kr into work-string
key = k1 characters beginning with character kf in work-string
index(k) = k
k = k + 1
ELSE fi = true
END DO WHILE
RETURN
```

Example 1.

```
2000
        REM
2010
        REM
               EXTRACT KEY FIELDS
2020
        REM
2100
       K = 0
2110
        PRINT D$;"READ ":OF$;",R";HS + K + R6
INPUT "1ST RECORD? ";WK$
2120
2130
        IF LEFT$ (WK$, LEN (EF$)) = EF$ THEN GOTO 2500
PRINT D$;"READ ";OF$;",R";HS + K → RG + KR;",B";KF
INPUT "KEY FIELD? ";WK$
2140
2150
2160
                    LEFT$ (WK$,KL)
      IX(K) = K
2180
2200
        60TO 2600
2500 \text{ FI} = 1
      IF FI = 0 THEN GOTO 2120
2600
2990
        RETURN
```

Fig. 1. Reads the file to be sorted and extracts the key field from each group. As it does, it checks the first record of each group to see if it contains the end-of-file signal.

set to % rather than a control-D, the execution of the routine at 6000 just prints the message: "%OPEN CHAOTIC MESS,L41"

but DOS ignores it, and the file is not opened. The execution of the routine at line 2000 similarly prints the message:

"%READ CHAOTIC MESS,R3"

Since I had said that the file had a header which was three records long, this was the correct command to be issued.

In order to understand why this is so, two things must be known about the READ command. First, when we are dealing with fixed-record-length files (and have opened them with an OPEN command containing an L parameter), the R parameter specifies which record is to be read by the next IN-PUT statement. This is called direct access, because in this case DOS will not just give us the next record from the file but will go directly to the specified record and access it. Thus, the READ command shown above says to DOS, "the next INPUT statement should receive the data from record number 3 (of the file currently open for reading) when it is executed."

It might appear that this would result in skipping over only two records (although the header was specified to be three records long!), but, in fact, it is skipping the first three records. DOS considers records to be numbered 0, 1, 2, ... rather than 1, 2, 3, . . . , and so, reading record number 3 skips records numbered 0, 1 and 2.

In the debugging run, the pro-

gram after printing the READ command asked for input (1ST RECORD?). Had the program actually opened the file and issued the READ command to DOS, the INPUT statement would have received its input from the file. However, in this debugging run, statement 2130 was just a normal INPUT statement that asked for data from the keyboard.

I responded on the keyboard by typing "NOT AN EOF." Since this simulated record did not match the end-of-file signal which I had specified, the program went on to read the record containing the key field. It issued the command "% READ CHAOTIC MESS,R6,B7," setting up the next INPUT statement to read from record number six starting with the byte numbered seven.

Studying this message, I discovered two errors! The routine should have been reading the sixth record starting with the seventh byte, but it was asking for the seventh record starting at the eighth byte! So, I made a note to change line 2150 to:

2150 PRINT D\$;"READ";OF\$;",R";HS+K *RG + KR - 1;",B";KF - 1

The program then executed line 2160, and I pretended to be the disk by typing:

7890123456789012345678901234567890

The routine stored the key and asked again for the 1st record (meaning the 1st record of a record group). This time it was asking to read record number 17 (the 18th record of the file), which was correct for the file. which was specified to have a

3-record header and record groups consisting of 14 records.

I responded with "END-OF-FILE-MARK," which was the end-of-file signal that I had specified for the file. The routine correctly recognized the end-of-file signal and exited. The program called the routines at lines 1000 and 3000 and then the routine at line 4000. That routine printed the correct CLOSE command and exited to the top level program, which executed the END state-

At this point, I had discovered the two errors in statement 2150, but I had not yet checked out the part of the routine that stored the keys.

Since I had an appropriate kind of file available (see Fig. 1a, part 1) and the program seemed to be working well, I decided to begin using DOS and real files for my checkout runs. I corrected statement 2150. changed statement 390 to set D\$ to a control-D and changed line 580 to go to the following debugging routine, which I added at line 10000:

10000 FOR K = 0 TO 10 10010 PRINT K;" ";IX(K);" ";KY\$(K) 10020 NEXT K 10030 END

My next debugging run gave the appearance of working correctly, except that the program did not recognize the end-of-file

```
JRUN
WHAT IS THE NAME OF THE FILE TO BE
SORTED? CHAOTIC MESS
WHAT IS TO BE THE NAME OF THE SORTED
FILE? A GOOD SORT
THE INPUT FILE MUST BE A FIXED RECORD
LENGTH FILE.
WHAT IS THE LENGTH, IN CHARACTERS, OF
THE RECORDS (EXCLUDING THE FINAL (CR))? 40
HOW MANY RECORDS ARE IN A RECORD GROUP
IN THE INPUT FILE? 14
WHICH RECORD, WITHIN A RECORD GROUP
CONTAINS THE KEY FIELD? 3
WHICH CHARACTER, WITHIN THAT RECORD IS
THE FIRST CHARACTER OF THE KEY FIELD?
HOW LONG, IN CHARACTERS, IS THE KEY
FIELD? 25
HOW LONG, IN RECORDS, IS THE HEADER ON
THE INPUT FILE? 3
EACH FILE MUST END WITH AN 'END-OF-FILE
RECORD.
         THIS IS A RECORD WHICH DOESN'
GET SORTED BUT CONTAINS A STRING OF
CHARACTERS WHICH IS UNIQUE.
WHAT DOES THE EOF RECORD CONTAIN? END-OF-FILE-MARK
MOPEN CHAOTIC MESS,L41
%READ CHAUTIC MESS,R3
1ST RECORD? NOT AN EDF
*READ CHADTIC MESS,R6,B7
KEY FIELD? 7890123456789012345678901234567890
%READ CHAUTIC MESS,R17
1ST RECORD? END-OF-FILE-MARK
```

Fig. 2. Sample run. Illustrates a versatile debugging technique that can be used with Apple DOS. The string variable D\$ has been assigned the value %, which allows simulating the actions of the disk by making entries at the keyboard. The lines that begin with the character % show the commands that would have been issued to DOS. Input statements, which would have read data from the disk file, are executed in the normal manner and expect to receive data entered at the keyboard.

```
IS THE NAME OF THE FILE TO BE
SORTED? PEOPLE
WHAT IS TO BE THE NAME OF THE SORTED
FILE? PEOPLE INDEX
WHAT IS THE LENGTH, IN CHARACTERS, OF
THE RECORDS (EXCLUDING THE FINAL (CR>)? 20
HOW MANY RECORDS ARE IN A RECORD GROUP
IN THE INPUT FILE? 3
WHICH RECORD, WITHIN A RECORD GROUP
CONTAINS THE KEY FIELD? 3
WHICH CHARACTER, WITHIN THAT RECORD IS
THE FIRST CHARACTER OF THE KEY FIELD?
HOW LONG, IN CHARACTERS, IS THE KEY
FIELD? 8
HOW LONG, IN RECORDS, IS THE HEADER ON
THE INPUT FILE? 6
WHAT DOES THE EOF RECORD CONTAIN? END-OF-FILE
1ST RECORD? BLOW JOE
KEY FIELD? 1ST RECORD? B.
KEY FIELD? 1ST RECORDS
KEY FIELD?
            1ST RECORDS
KEY FIELD? 1ST RECORD? EN.
KEY FIELD? 1ST RECORD?
KEY FIELD? 1ST RECORD?
KEY FIELD? 1ST RECORD?
♦♦♦DISK: END OF DATA ERROR
BREAK IN 2130
360TO 10000
0 0 CLASS 1A
1 1 CLASS 1B
 2 CLASS 4A
3 CLASS 3A
 4 CLASS 2A
5 5 CLASS 1A
```

Fig. 3. The first debugging run to use real data from the disk and to invoke Apple DOS reveals a problem caused by a bug in Apple DOS. The file used as input is shown in Fig. 1a (part 1). You should compare the responses given during this run with the format shown in Fig. 1b (part 1).

```
signal and attempted to read
records past the end of the data
in the file. When this occurs
DOS prints the message:
```

***DISK: END OF DATA ERROR and causes a break in the program.

Since this part of the program had appeared to work correctly when I was simulating the disk from the keyboard, I knew that if the program was getting the correct data from the disk it would recognize the end-of-file signal. Furthermore, the READ commands which were printed in the earlier run had included the correct record number for the first record of the record groups.

In order to find out what was happening, I added a statement after line 2130 to print out the contents of WK\$ and ran the run again. This run is shown in Fig. 3. The program had indeed gotten the correct data for the first time it read the first record of the record group ("BLOW JOE..."), but all of the subsequent tries had produced some garbage. A little study revealed that, after the first time, statement 2130 had input data starting with the 13th character of

```
the first record of each record
group! This was caused by the
only bug (which shows what a
good job Apple did on DOS)
that I have found in DOS.
```

When the B parameter is used in a READ command to DOS it remains set until superceded by a B parameter in another READ command. Furthermore, once it has been set it is not reset to 0 even by RUN commands! Therefore, statement 2130 got the correct data the first time it was executed, but statement 2150 set the B parameter to 13, and all subsequent executions of 2130 started with data at the 13th character of the record.

I made a note to add ";B0" to the end of statement 2120. Then, in order to see if the key extraction was working correctly, I punched in "GOTO 10000." The results, shown at the bottom of Fig. 3, proved that the key fields and their record-group numbers were being extracted correctly. In order to thoroughly exercise the key extraction routine, I made several debugging runs whose results are shown in Figs. 4a through 4d.

An Efficiency Improvement

I had known from the start that there was a special case which the key extraction routine (as specified) would not take advantage of: If the key field was in the first record of a record group (which would be true for all of those files which had only one record in a record group, and frequently true for others as well), the routine would read the first record twice! It would read it first when looking for the end-of-file signal, and again to get the record which contained the key.

I had been following a programming practice that I use when working with interactive programming systems or a personal computer. I first program the routine and check it out without including any of the code to handle special cases, particularly those that only affect the efficiency of the routine. Once I have that version of the routine working, I add the code to handle the special cases and debug it again.

```
b. 1ST RECORD? BLOW JOE
1ST RECORD? BLOW JOE
                                                   KEY FIELD? 1ST RECORD? NIMBLE JACK B.
KEY FIELD?
                         NIMBLE JACK B.
KEY FIELD? 1ST RECORD?
                                                              1ST RECORD?
                         CINDERELLA
                                                   KEY FIFLD?
                                                                            CINDERELLA
KEY FIELD?
            1ST RECORD?
                         KENT CLARK
                                                   KEY FIELD?
                                                                            KENT CLARK
KEY FIELD?
            1ST RECORD? BULLWINKLE GEN.
                                                               1ST RECORD?
                                                                            BULLWINKLE GEN.
                                                   KEY FIELD?
KEY FIELD? 1ST RECORD?
                         CROWLEY ALEISTER
                                                   KEY FIELD? 1ST RECORD? CROWLEY ALEISTER
                                                   KEY FIELD? 1ST RECORD? END-OF-FILE
KEY FIELD? 1ST RECORD? END-OF-FILE
AT ROUTINE 1000
                                                      ROUTINE 1000
AT ROUTINE 3000
                                                   AT ROUTINE 3000
0 0 CLASS 1A
                                                     0 CHICAGO
                                                       CANDLESTICK PARK
  1 CLASS 1E
2 2 CLASS 4A
3 3 CLASS 3A
                                                   2 2 SHANTYTOWN
                                                       METROPOLIS
                                                   3 3
  4
    CLASS 28
                                                       NORTH WOODS
5 5 01822 18
                                                     5 HIGHER PLANES
                                                   6
1ST RECORD? BLOW JOE
                                                  1ST RECORD? BLOW JOE
                                                   KEY FIELD? 1ST RECORD? NIMBLE JACK B.
KEY FIELD? 1ST RECORD? CINDERELLA
KEY FIELD? 1ST RECORD? NIMBLE JACK B.
KEY FIELD? 1ST RECORD? CINDERELLA
KEY FIELD? 1ST RECORD?
                         KENT CLARK
                                                   KEY FIELD? 1ST RECORD?
                                                                            KENT CLARK
                                                   KEY FIELD? 1ST RECORD?
KEY FIELD? 1ST RECORD?
                         BULLWINKLE GEN.
                                                                            BULLWINKLE GEN.
KEY FIELD? 1ST RECORD? CROWLEY ALEISTER
                                                   KEY FIELD? 1ST RECORD? CROWLEY ALEISTER
KEY FIELD? 1ST RECORD? END-OF-FILE
                                                   KEY FIELD? 1ST RECORD? END-OF-FILE
AT ROUTINE 1000
AT ROUTINE 3000
                                                   AT ROUTINE 1000
AT ROUTINE 3000
0 0 BLOW JOE
                                                   0 0 NDBA
                                                       GH J
  1 NIMBLE JACK B.
2 2 CINDERELLA
                                                   S S LDIG
                                                   3 3 RON6
  3 KENT CLARK
  4 BULLWINKLE GEN.
                                                       MPAN
  5 CROWLEY ALEISTER
                                                       SICI
```

Fig. 4. (a) Key field is eight characters long, starting with the 13th character of the third record. (b) Key field is 20 characters long, starting with the first character of the second record. (c) Key field is 20 characters long, starting with the first character of the first record. (d) Key field is four characters long, starting with the third character of the third record.

When the special cases deal only with efficiency issues, the subsequent debugging is particularly easy since the routine should give exactly the same results after the new code is added

In the case of the key extraction routine I added the following three statements:

2145 IF KR<>1 THEN GOTO 2150 2147 KY\$(K) = MID\$ (WK\$,KF,KL) 2149 GOTO 2180

I then ran the same tests again and got the same results as from the previous runs.

Sorting the File

I won't attempt to give a tutorial on sorting and sorting algorithms here. There are several excellent sources of information on these subjects (see references at the end of this article). I used the "Shell sort" algorithm from Software Tools by Kernighan and Plauger (p. 106) for the specification of the sorting routine for this file sort program because, although it is appreciably faster than the simple "bubble sort," it is easy to program and check out. I modified Kernighan and Plauger's algorithm to reflect the variable names I had chosen for my program (see Example 2).

The basic strategy of a Shell sort is to set an initial gap size (about half the length of the file) and compare the elements which are gap-size apart in the file, exchanging them as necessary. The gap is then reduced and the process repeated. When the gap has been reduced to zero, the sort is complete.

I used the above specifica-

```
1000
       REM
              SHELL SORT FOR STRINGS
1010
       REM
1021
       PRINT : PRINT "--
1100 GA =
              INT (K / 2)
1110 I = GA +
      J = I - 6A
1120
1130 JG = J + GA
1131 JG = J + GA
1131 PRINT "<"; LEFT$ (KY$(J),6);"> <"; LEFT$ (KY$(JG),6);">";
1132 PRINT "GA=";GA;" I=";I;" J=";J;" JG=";JG
       IF KYS(J) (
1140
                       = KY$(JG) THEN GOTO 1400
1150 WK$ = KY$(J)
1155 W = IX(J)
1160 KY$(J) = KY$(J6)
1165 \text{ IX(J)} = \text{IX(JG)}
1170 KY$(J6) = WK$
1175 \text{ IX(J6)} = \text{M}
1200 J = J - GA
       IF J > 0 THEN GOTO 1130
1400 I = I + 1
1410 IF I <
                 = K THEN GOTO 1120
1500 GA =
             INT (68 / 2)
       IF 68 >
                   = 1 THEN
                                GDTD 1110
       RETURN
1990
```

Fig. 5. The actual sorting is done by this Shell sort routine. The routine is an implementation of the Shell sort algorithm from Kernighan and Plauger's book, Software Tools.

tion to write the sort routine that appears in Fig. 5. This routine is a direct translation of the specification into Applesoft II BASIC. I did not expect that the routine would run correctly the first time, so I included lines 1131 and 1132 to print some debugging information during the execution of the routine. I also knew that the top-level program would call the debugging routine at line 10000 after it called the sorting routine, which would show me the keys and their indices after sorting.

The first debugging run for the sort routine is shown in Fig. 6. The sorting routine printed, just prior to each comparison, the jth and the jgth keys and the values of GA, I, J and JG. After the sorting routine had returned, the top-level program called the stub for the routine at line 3000 and then called the

```
<HIGH J> <COMPAN>6A=3 I=4 J=1 J6=4
           <MAGICI>6A=3 I=5 J=2 JG=5
(GDLDIG)
<STRONG>
           <>68=3 I=6 J=3 J6=6
(COMPAN)
           <60LDI6>68=1 I=2 J=1
                                      .16=2
<GDLDIG>
           <>GA=1 I=3 J=2 JG=3
<COMPAN>
           <>6A=1 I=3 J=1 J6=2
           <HI6H J>6A=1 I=4 J=3
<MAGICI>6A=1 I=5 J=4
(GOLDIG)
<HIGH J> <MAGICI>GA=1 I=5 J=4 JG=5
<MAGICI> <STRONG>GA=1 I=6 J=5 JG=6
AT ROUTINE 3000
  0 WINDBAG
1
    COMPANION
  4
     GOLDIGGER
    HIGH JUMPER
    MAGICIAN
    STRONG ARM
```

Fig. 6. The results obtained during the first debugging run show that the sort routine and the routine which extracts the keys are in disagreement about the location of the keys.

debugging routine at line 10000, which dumped the indices and keys. A little study revealed that in

some sense everything seemed to be off by 1. For example, the first line of debugging output says that the first and fourth keys are being compared, but referring back to Fig. 1 (part 1). I saw that "HIGH JUMPER" and "COMPANION" were really the second and fifth keys! Further study verified that although the routine which extracted the keys put the first key in KY\$(0), the second key in KY\$(1), etc., the sort routine was written as though the first key was in KY\$(1), the second in KY\$(2), etc.

I could have changed either of these routines to correct the problem. I chose to change the key extraction routine rather than the sorting routine, simply

because I thought that would be the easiest to change. I made the following changes to the key extraction routine:

2147 KY\$(K + 1) = MID\$(WK\$,KF,KL)2170 KY\$(K + 1) = LEFT\$(WK\$,KL) 2180 IX(K + 1) = K

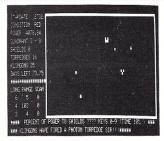
Fig. 7 shows the results I got from the next debugging run. Everything seemed to be working correctly! The keys were in sort, and the indices had the correct values. For example, the results showed that after the sort the first key was "COM-PANION" (it was now in KY\$(1)). and that it came from the fourth record group (because IX(1) contained a 4). What I had thought would be the only hard part of the program had turned out to be quite simple! Only one routine remained to be written

Writing the Sorted File out to the Disk

My original plan had been to

```
gap = K/2
DO WHILE gap>0
   i = gap + 1
    DO WHILE I< = K
        i = i - gap
       DO WHILE j>0
           ig = i + gap
           IF i - th kev>ia - th kev
               THEN exchange the J-th and jg-th keys and their indices
           i = j - gap
       END DO WHILE
       i = i + 1
   END DO WHILE
   qap = qap/2
END DO WHILE
RETURN
                             Example 2.
```

SOFTWARE - TRS-80 - SOFTWAR

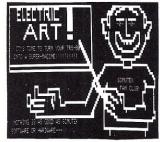


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write a program that would extract the key fields and their indices from an unsorted file, sort them and use the sorted indices to read the unsorted file (in sort order) and write out a new file which would be sorted. As I approached the task of writing the routine that would read the unsorted file and write the sorted file, it occurred to me that I would rather make use of a concept known as indexed sequential files.

Under my original plan, if I needed to have a file sorted in three different ways (e.g., by last name, by city and by zip code). I would have to keep three full copies of the file. If the file was at all large, this could become a serious problem. An indexed sequential file is really two files: a data file and an index to it. The index contains the record (or record group) numbers arranged in some special order and can be used to read the file according to some special sequence.

For example, the index prepared by the sort routine can be used to read the unsorted file in the sorted sequence. The index constructed during the debugging run shown in Fig. 7 can be used to read the unsorted file in a sequence, which is sorted by occupation. Thus it says that if you want to read the file in sort order by occupation, you should first read record group 4, then record group 2, then record group 1, etc. The index file will be much smaller than the actual file, and you could afford to have several index files (for different sort orders) at a relatively small expense in disk space.

As a result of these considerations, I decided to simply write out the sort index rather than the sorted file². After making this decision, I wrote the routine shown in Fig. 8. This routine simply opens the file SF\$ for

²You might enjoy, as an interesting and useful exercise, adding a new routine that gives the user the option of writing out the sorted file. The routine at line 7000 can easily be modified to do this job.

```
<WINDBA> <STRONG>6A=3 I=4 J=1 J6=4
<HIGH J>
          <COMPAN>GA=3 I=5 J=2
                                JG=5
(GOLDIG)
          <MAGICI>6A=3 I=6
                            J=3
                                J6=6
                        I=2 J=1
                                JG=2
<STRONG>
          GOLD16>6A=1
                        I=3 J=2
                                J6=3
          GOLDIG>GA=1
(COMPAN)
                        I=3 J=1
                                JG=2
(STRONG)
           WINDBA>6A=1
<WINDBA>
         <HIGH J>6A=1
                        I=5 J=4
                                J6=5
                       I=5 J=3
(STRONG)
          <HIGH
                J>68=1
                                J6 = 4
(GOLDIG)
                J>GA=1
                        I=5 J=2
                                JG=3
(WINDBA)
          <MAGICI>6A=1
                       I=6 J=5
                                JG=6
<STRONG>
         <MAGICI>6A=1
<HIGH J> <MAGICI>GA=1 I=6 J=3
AT ROUTINE 3000
0
 0
  4 COMPANION
3
 2
    GOLDIGGER
    HIGH JUMPER
    MAGICIAN
    STRONG ARM
WINDBAG
```

Fig. 7. The corrections made to the key extraction routine clear up the problems. The Shell sort routine is working correctly.

```
WRITE THE SORT INDEX
3010
      REM
3020
      REM
3030
      PRINT DS;"OPEN ";SFS
3100
      PRINT DS;"WRITE ";SFS
3110
3120
      FOR I = 1 TO K
       PRINT IX(I)
3140
3150
      NEXT I
      PRINT
             "END-OF-FILE"
      PRINT DS
      RETURN
```

Fig. 8. This routine simply opens the file for writing, writes out the sorted index, writes an end-of-file signal and turns off the writing of the file.

```
7000
      REM
701Ó
      REM.
           LIST THE SURTED FILE
7020
      REM
      INPUT
             "DO YOU WANT TO LIST THE SORTED FILE?
                                                       " FANS
7100
         LEFTS (ANS,1)
7110
                                   " THEN GOTO 7990
7120
      REM
           TURN ON THE PRINTER
      GDSUB 8000
7130
7150
      REM OPEN THE DATA FILE
      PRINT D$;"DPEN ";DF$;";L";RL + 1
FOR JJ = 1 TO K
FOR KK = 1 TO R6
7170
7180
7190
      PRINT DS; "READ "; OFS; ",R"; HS + IX(JJ) + RG + KK - 1
7200
      INPUT LIS
7210
      PRINT LIS
7220
      NEXT KK
      IF RG > 1 THEN PRINT : PRINT : PRINT
7230
      NEXT JJ
7240
            TURN OFF THE PRINTER
7260
      60SUB 9000
7990
      RETURN
8000
      REM
             TURN ON THE PRINTER
8010
      REM
      PRINT DS: "BLOOD RS232 DDS 36K"
8100
      CALL 768
8110
      RETURN
9000
      REM
             TURN OFF THE PRINTER
9010
      REM
9100
      PRINT D$;"PR#0"
9110
      RETURN
```

Fig. 9. Uses the sorted index prepared by the Shell sort routine to list the unsorted file in sorted order. It uses the direct access feature of Apple DOS to read the records in the proper order.

writing, writes the index to this file and writes "END-OF-FILE" as an end-of-file signal. The only interesting aspect of this routine is the statement at line 3160.

As I discussed previously, the OPEN and WRITE commands to Apple DOS say, "until I tell you otherwise, all PRINT statements should write data to the specified file." There are two ways of rescinding this command. The first is to issue a CLOSE command (see Fig. 7, part 1). The second way to turn off the writing is to issue any other Apple DOS command. Apple DOS commands are issued by executing a print statement that begins a line with a control-D. Therefore, line 3160 will issue an Apple DOS command when it is executed.

It is a peculiar Apple DOS command because it *only* contains a control-D. Such a statement issues a do-nothing command to Apple DOS, but since *any* command to Apple DOS shuts off any currently active WRITE (or READ) commands, it does so for the WRITE command issued at line 3110. Line 3160 is only included as a precautionary measure. When that statement is executed, the routine has finished writing the in-

dex out to the file. It ensures that any subsequent PRINT statements won't cause data to be written to the index file.

I could have simply closed the file, but for no particularly important reason I had chosen to close all files in the wrap-up routine at line 4000. The statement at line 3160 would protect the index file from subsequent PRINT statements and allow other routines to be executed prior to the closing of the file in the wrap-up routine.

In order to make sure that I did not forget to close the index file, I added the statement:
4100 PRINT D\$;"CLOSE";SFS to the routine at 4000 (see Fig. 7, part 1).

Having decided to write out just the sort index, rather than a sorted file, I also decided that I should add a routine that would allow the user to (optionally) have the sorted file printed or displayed. Since the routine at line 3000 was quite simple, I decided to write the printing routine and use it to check out the routine which writes out the index.

Printing the Sorted File

My first step in adding the printing routine was to add the following statements to the

top-level program: 580 LIST THE SORTED FILE 590 GOSUB 7000 600 END

I then wrote the routine shown in Fig. 9. This routine is similar to the extract keys routine. There are, however, a couple of interesting features that I should point out.

Perhaps the routine's most important characteristic is that it assumes that the user has a printer on the system. The routine at line 8000 is the one that is supposed to turn on the printer, and the routine at line 9000 turns it off. If you do not have a printer, the lines:

8025 RETURN 9025 RETURN

should be added to the program. Adding those two lines will deactivate those routines, and the routine at line 7000 will simply cause the sorted file to be displayed on the television or monitor screen.

Although lines 8100 and 8110 are peculiar to my particular printer and the software driver which it requires, I have included those lines in order to illustrate another aspect of Apple DOS. Line 8100 issues an Apple DOS command. It has the same effect that typing BLOAD RS-232 DOS 36K on the keyboard does. Thus, the command issued by line 8100 causes the binary file named RS-232 DOS 36K to be loaded from the disk. This is the name of the software driver which is required for my particular printer. The CALL statement at line 8110 causes the printer to be activated by calling the software driver loaded by the previous statement.

The routine that extracted the key fields (see Fig. 1) used the direct access feature to read only the first record and the key-containing record within each record group. The routine at line 7000 uses the same feature to read record groups from the unsorted file in sorted order. It uses the index file (which need not be read from the file since it is still in the array IX) to decide which record group should be read next.

You should study lines 7170 through 7220 to see how this is

done. The FOR JJ loop uses the index IX(JJ) to determine which record group should be read next. The FOR KK loop then reads and prints the records in the selected record group. If our previous discussions have been clear, you should have no difficulty understanding how this routine does its job.

Fig. 10a shows the results I obtained when I sorted the file shown in Fig. 1a (part 1) using characters 1-12 of the third record as the sort key and had it printed by the routine at line 7000. Fig. 10b shows the results of sorting the same file on a key defined as all 20 characters of the first record of each record

An Application of the File Sort Program

An interesting application of the file sort program is its use to produce a special kind of directory of magazine articles. This kind of directory was originally called a KWIC Index. KWIC stands for Key-Word-In-Context. A KWIC index is built by taking (in this case) magazine titles and rotating the words in the title so that we get one line for each important word in the title. Then sort the resulting lines.

The result is an alphabetic list that contains each title many times. In fact, each title appears once in the KWIC index for each important word in

a.	BULLWINKLE MORTH WOODS			b.	BLOW JOE CHICAGO		
	COMPANION	CLASS	28		WINDBAG.	CLASS	1Ĥ
	CINDERELLA SHANTYTOWN				BULLWINKLE (SEN.	
	GOLDIGGER	CLASS	4A		COMPANION	CLASS	28
	NIMBLE JACK				CINDERELLA SHANTYTOWN		
	HIGH JUMPER		1 B		GOLDIGGER	CLASS	48
	CROWLEY ALE				CROWLEY ALE		
	MAGICIAN		18		MAGICIAN		18
	KENT CLARK				KENT CLARK METROPOLIS		
	STRONG ARM	CLASS	3 A		STRONG ARM	CLASS	38
	BLOW JOE CHICAGO				NIMBLE JACK		
	WINDBA6	CLASS	18		HIGH JUMPER		1 B
					TO 200		

Fig. 10. Results of sorting the file on the first 12 characters of

the third record and the contents of the first record are shown. Sorted by occupation (a) and sorted by name (b).

- BUSINESS APPLICATIONS A SYSTEM FOR THE PROFESSIONAL -BREHM JA78 GROWING WITH KIM EXPANSION PC BOARD -EATON JA78 HAS GODBOUT DONE IT AGAIN? ECONORAM II -GARETZ JA78
 THE TRS-80 HOW DOES IT STACK UP? -JUGE JA78 A TALE OF TWO BASICS WHICH DNE FOR YOUR 6800 -DIDDAY JA78
- BUSINESS APPLICATIONS A SYSTEM FOR THE PROFESSIONAL -BREHM imes APPLICATIONS A SYSTEM FOR THE PROFESSIONAL -BREHM imes BUSINESS SYSTEM FOR THE PROFESSIONAL -BREHM imes BUSINESS APPLICATIONS A PROFESSIONAL -BREHM imes BUSINESS APPLICATIONS A SYSTEM FOR THE -BREHM imes BUSINESS APPLICATIONS A SYSTEM FOR THE PROFESSIONAL GROWING WITH KIM EXPANSION PC BOARD -EATON >< JA78 KIM EXPANSION PC BOARD -EATON >< GROWING WITH JA78 EXPANSION PC BOARD -EATON >< GROWING WITH KIM PC BOARD -EATON >< GROWING WITH KIM EXPANSION BOARD -EATON >< GROWING WITH KIM EXPANSION PC -EATON X GROWING WITH KIM EXPANSION PC BOARD JA78
 HAS GODBOUT DONE IT AGAIN? ECONORAM II -GARETZ X GODBOUT DONE IT AGAIN? ECONORAM II -GARETZ >< DONE IT AGAIN? ECONORAM II -GARETZ >< HAS GODBOUT AGAIN? ECONORAM II -GARETZ >< HAS GODBOUT DONE IT ECONORAM II -GARETZ >< HAS GODBOUT DONE IT AGAIN? II -GARETZ >< HAS GODBOUT DONE IT AGAIN? ECONORAM -GARETZ >< HAS GODBOUT DONE IT AGAIN? ECONORAM II TRS-80 HOW DOES IT STACK UP? -JUGE >< THE JA78
 HOW DOES IT STACK UP? -JUGE >< THE TRS-80 HOW JA78
 DOES IT STACK UP? -JUGE >< THE TRS-80 HOW JA78
 STACK UP? -JUGE >< THE TRS-80 HOW DOES IT JA78 UP? -JUGE >< THE TRS-80 HOW DOES IT STACK JA78 -JUGE >< THE TRS-80 HOW DOES IT STACK UP? JA78 TALE OF TWO BASICS WHICH ONE FOR YOUR 6800 -DIDDAY THEE OF TWO BASICS WHICH ONE FOR YOUR 6800 -DIDDAY >< A THEE OF JA78
 THO BASICS WHICH ONE FOR YOUR 6800 -DIDDAY >< A THEE OF JA78
 BASICS WHICH ONE FOR YOUR 6800 -DIDDAY >< A THEE OF TWO JA78
 WHICH ONE FOR YOUR 6800 -DIDDAY >< A THEE OF TWO BASICS JA78
 ONE FOR YOUR 6800 -DIDDAY >< A THEE OF TWO BASICS WHICH JA78
 6800 -DIDDAY >< A THEE OF TWO BASICS WHICH ONE FOR YOUR 6800 JA78
 -DIDDAY >< A THEE OF TWO BASICS WHICH ONE FOR YOUR 6800 JA78

Fig. 11. Collection of magazine titles rotated and replicated in preparation for sorting. The sorted file will provide a KWIC index to the titles. (a) Partial sample of titles from the January 1978 issue of Kilobaud. (b) Titles rotated and replicated so that there is one copy for each important word in the

two from the title of the article you are looking for. I have a program that, given a file contain-

ing the titles, prepares a new file containing the rotated titles

(which can then be sorted by

the file sort program to produce a KWIC index). In Fig. 11a I have shown a small sample file which contains some of the article titles from the January 1978 issue of Kilobaud. The file, which was produced by the program that rotates the titles, is shown in Fig. 11b. The rotating program doesn't know what important words are; it just contains a list of unimportant words such as a, the, etc. Finally, Fig. 12 shows the KWIC index which was produced by the file sort program by sorting the file shown in Fig. 11b.

I hope you have learned something which will be useful to you as you have read this discussion, that you may find the file sort program useful and that you enjoy your Apple II as much as I do.

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DOES IT STACK UP? -JUGE >< THE TRS-80 HOW JA78
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HAS GODBOUT DONE IT AGAIN? ECONORAM II -GARETZ >< JA78
HOW DOES IT STACK UP? -JUGE >< THE TRS-80 JA78 X HAS GODBOUT DONE IT AGAIN? ECONORAM JA78 -GARETZ KIM EXPANSION PC BOARD —EATOM imes GROWING WITH JA78 ONE FOR YOUR 6800 —DIDDAY imes A TALE OF TWO BASICS WHICH JA78 PC BOARD -EATON >< GROWING WITH KIM EXPANSION JA78 PROFESSIONAL -BREHM X BUSINESS APPLICATIONS A SYSTEM FOR THE JA78
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SYSTEM FOR THE PROFESSIONAL -BREHM X BUSINESS APPLICATIONS A JA78
SYSTEM FOR THE PROFESSIONAL -BREHM X BUSINESS APPLICATIONS A JA78
TALE OF TWO BASICS WHICH DNE FOR YOUR 6800 -DIDDAY X A JA78
TRS-80 HOW DOES IT STACK UP? -JUGE X THE JA78
TWO BASICS WHICH DNE FOR YOUR 6800 -DIDDAY X A TALE OF JA78
TWO BASICS WHICH DNE FOR YOUR 6800 -DIDDAY X A TALE OF JA78 -JUGE >< THE TRS-80 HOW DOES IT STACK JA78 WHICH ONE FOR YOUR 6800 -DIDDAY imes A TALE OF TWO BASICS JA78

Fig. 12. A KWIC index of a small sample of titles shows the utility of such an index. The use of the hyphen preceding the author's name produces an index that begins with an author index of the titles. The remainder of the index makes it easy to locate an article even when you know only the general subject or one or two words in the title.

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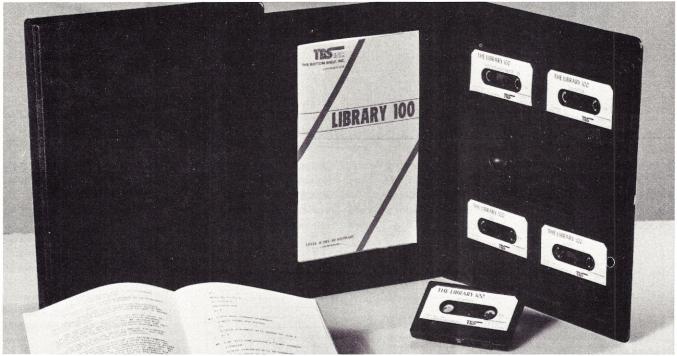
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The program mix is eclectric, interesting, and curious... If I had a Level II TRS-80 and one or more grade-school children, or if I were a hardcore software collector, or if I had little software and wanted to get a lot of it with a minimum of bother, I'd buy the Library 100." Stephen Gray, Creative Computing, April, 1979.

"...a basic computer library for the hobbyist, parent or business-man." Kilobaud Microcomputing, December 1978.

The programs are spread over five general categories; Finance, Education, Graphics, Home and Games. As an added bonus, the LIBRARY 100 contains Tiny PILOT, a condensed version of the high level language primarily used in education. It is perfect for teachers, parents, students and sales trainees. Using only six commands, even a child could be programming in minutes. The other programs are as follows:

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Base Numbers.

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Elf Meets a New Friend

In this case, the Elf's pal is an SWTP 6800 memory board.

Recently I was in the same dilemma as other computer hobbyists—I needed more money! I had wire-wrapped a Cosmac Elf with 256 bytes of RAM according to an article in *Popular Electronics*, but it was begging for more memory.

As a part-time hobbyist, I have limited time and a limited

budget. At the time, few companies offered bare PC boards, which I considered the best purchase. Bare boards are usually inexpensive; in the case of a memory board, I can purchase a 1K or 2K segment at a time as my budget allows.

I had had previous experience with SWTP in the audio field, and I was pleased with the price and quality of their products. At the time I placed my order with SWTP, only a 4K bare board was available. My next move was obvious: to mate my 1802-based Elf with the SWTP 6800 memory board.

4K Board Description

SWTP's board design is based on 2102 memory chips. Buffering and decoding are done with reliable TTL circuitry. As you can see from Fig. 1, there are 16 memory address lines, ten of which (Ao through Ao) are buffered with DM8097 Tri-state non-inverting hex buffers. The other six lines, A10 through A15, are routed to the 74LS138 3 to 8 decoders for address decoding. This allows placement of the board in any 4K segment of the total computer memory and also allows decoding of the individual 1K segments on each

The eight bidirectional data lines are buffered and controlled by DM8835 inverting bidirectional transceivers. Although the incoming sections are enabled at all times, this doesn't cause any problems because the 2102s have separate data in and data out lines. The output sections of the DM8835 chips are controlled by the R/W line and signals from the address decoder that are routed through a series of gates

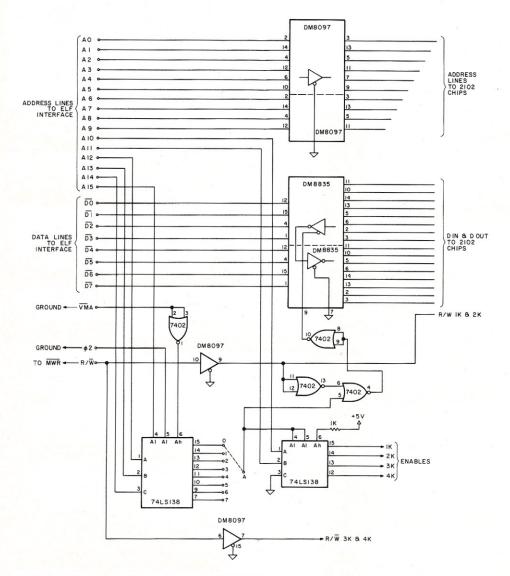


Fig. 1. Buffering and decoding section of the SWTP 4K memory board. Elf interface connections shown on left.

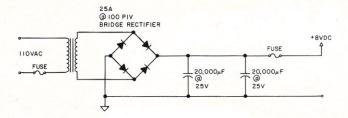


Fig. 2. Expansion power supply. Fuses selected according to load.

in the form of a 7402 quad 2 input NOR gate. The R/W line is previously buffered by a part of the DM8097 address line buffer.

The only other signal lines are VMA and 02, which are used to enable the first address decoder. VMA is valid low and is inverted by a section of the 7402. The only two lines remaining are the unregulated V+ line and ground. The V+ line supplies the on-board 7805 regulators to supply +5 V dc to all of the chips.

Putting It All Together

I searched through all of my discount-house catalogs to find the best prices for chips and sockets. By careful shopping I was able to keep the cost below \$80, which at the time was reasonable for 4K of static RAM. Assembly was easy. I soldered all the sockets, capacitors and

resistors in place and then simply installed the chips.

A friend with an SWTP 6800 computer let me install the board in his mainframe to check the operation of the memory. It worked flawlessly! My next step was to interface the board to my 1802. The Elf needed a heftier power supply, and the address, data and signal lines needed buffering.

Elf Additions

The power supply of the original Elf supplied only approximately 600 mA. Any major memory additions required power in Amperes instead of milliamps, so I chose to build a supply that could deliver 6 A to accommodate any future expansion. I purchased a surplus transformer, and as you can see from Fig. 2, I used a standard circuit to supply approximately 8

FROM COSMAC ADDRESS PINS TO SWTP MEMORY BOARD DM8097 AO AO AI A2 A2 Δ3 - 43 A5 A5 A6 A6 CD 4042 AIO CD 40 42 A12 A 14 A15 DM8097 MRD MWR MWR FROM COSMAC TO MEMORY

Fig. 3. Method used to latch and buffer the address lines. Also, buffering for the MRD and MWR lines.

volts dc to the system.

My next concern was the address lines. RCA uses multiplexing to place 16 bits of information on 8 pins. The high-order 8 bits of the address are placed on the pins during the first half of a machine cycle, and the loworder 8 bits are placed on the same pins during the remainder of a machine cycle.

The 1802 generates a timing pulse, TPA, during the first part of a cycle that can be used to strobe the high-order bits into a latch. After TPA goes low, the low-order address bits are present. I used two CMOS CD4042 quad latches to capture the high-order bits for address lines As through A15 (see Fig. 3). After this, I buffered the lines with DM8097 hex buffers and used the extra sections to buffer the MRD and the MWR lines.

For the data lines I used the same transceivers as on the memory board to keep things simple. I used the MRD and MWR lines to gate the transceivers in and out, respectively. Since the signals (MRD and MWR) are never active at the same time, the data direction cannot be confused. Fig. 4 shows the simple circuit.

The 1802 has built-in provisions for DMA by way of two lines, DMA-in and DMA-out. When either of these two lines is brought low, the CPU prepares for DMA and gives up control of the data lines by placing them in a high-impedance state. For this reason, I didn't have to decode a high-impedance state for the data buffers to isolate the CPU data lines from the bus, as

SWTP does for the 6800 comput-

The last two signals were VMA and 02. Fig. 1 shows that these signals tell the address decoder that the 6800 CPU is outputting a valid memory address. To keep my parts count to a minimum, I tried grounding these two inputs to the memory board instead of synthesizing a signal to emulate the 6800. The memory operated without an er-

I experimented with the VMA input by putting TPA on it to keep the address decoder on the memory board from responding until after the high-order memory address bits were latched and the low-order bits were present. The board also operated OK in this mode.

Interface Wiring

I wired between the Elf and the memory board with two DIP connectors and ribbon cable, keeping the cable as short as possible to avoid any cross-talk problems. I wire-wrapped the buffering and decoding logic on a piece of perfboard the same size as the Elf to allow room for expansion. Everything on my expansion interface board was mounted in sockets for easy assembly and troubleshooting.

The result of my experiment put me one step closer to my goal of running Tiny BASIC and also provided me with a lot of fun and insight into the operation of the 1802 and also the 6800 CPUs. I plan to add a keyboard and video monitor, as well as I/O ports to accommodate my future projects.

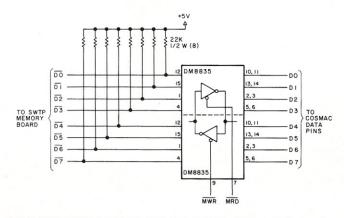


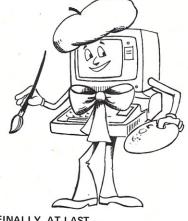
Fig. 4. Expansion interface data line buffers. Also note bus pull-up resistors.

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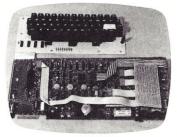


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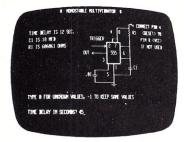
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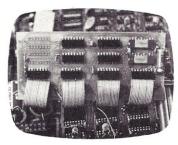
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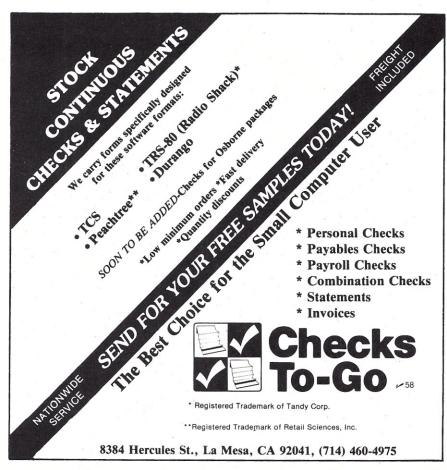


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The Future Office: In the Home

"I won't be at the office today—I've got some work to do at home."

Jeff Noynaert Managing Editor **Future Office Abstracts** PO Box 29251 San Antonio, TX 78229

evelopments in communication and computer technology are leading us to more versatile and distributed systems. Soon, inexpensive home-based computers will be able to simulate the functions of large office

This article describes the uses that Mr. and Ms. Doe will find for these systems and several effects that these changes will have on society. This is not seen as a direct replacement for today's methods, but as a new competitor (and tool) for them in the marketplace. The article calls for authors to develop and expand these and related subjects and to alert the American public to their future resources.

Background

Who would have thought that one day consumers would be able to perform the very functions that for so long have been the businessman's role in society? Not that business is on the way out . . . far from it. But soon the face of business will be quite different from what it is today, and the once distinct division between the roles of buyer and seller will become blurred.

When computers were first developed they were of no commercial value. After working out a few bugs,



What big businesses are dreaming of doing now, everyone will be able to do in only a few more years.



investing a few million dollars and discovering a few technological breakthroughs, several users could join together to take advantage of one system and share the expenses. Several million dollars later, the largest corporations could afford to own (or lease) one for themselves. The difference was that the cost had come down, thus making computers profitable to own. As their price continued to drop, more companies found it practical to use them.

This is similar to the way that word processing was introduced into business offices. First, word processing was so costly that its only practical use was correcting computer programs . . . and only then because there was a computer involved and waiting at the time. With advances in circuit integration and available research and development dollars, a true word processor was offered to the business community.

Still, the best ones were more expensive than the secretaries that they replaced, and users had to settle for paper tape machines, if they could justify having one at all. With time, word processors began using magnetic media (because magnetic media had become less expensive) and became more applicable to routine office correspondence.

Establishing word-processing centers was suggested by the vendors in order to serve several persons and therefore distribute the cost . . . much like time-sharing one computer between several businesses. Today, word processors no longer need to be shared in order to justify their expense, because today's lower prices make it possible to have them distributed throughout the company.

The point is that the cost of computers-and all the related hardware—is continuing to drop and will continue to drop for enough years to allow everyone in the country to own complex computing systems, much the same way we now own calculators and television sets.

What big businesses are dreaming of doing now, everyone will be able to do in only a few more years. Electronic mail, advanced information management and data base systems are just beginning to be implemented in the largest corporations. Vendors

throughout the world are falling over themselves to develop less expensive, simpler systems.

As always, functions are first added to a large centralized computer, making these new functions available to several users throughout the company or among several companies. Centralization always occurs first because it allows several persons to share system

Eventually though, when the prices drop, the advantages of decentralization (or distributed systems) become evident. The distributed systems don't require a connection to a central host; they allow local control, reduce bottlenecks, eliminate the possibility that all the systems will go down at once, add privacy and let you personalize the features of your system. The most advanced systems involve an ever-changing balance of centralization and decentralization.

Computers were first used to automate clerical tasks. Then many other cause-and-effect jobs were described in the form of a program. Today, we have automated banks, automated order and bill processing, automated mail delivery. Anything that can be described in a certain cause-andeffect series of events will be automatic.

A Forecast

Within ten years nearly everyone will be able to afford a computer that can perform all of these business functions. Each family will be able to simulate a large office staff. Some businesses will be able to offer reduced prices by depending more on the consumers' new abilities.

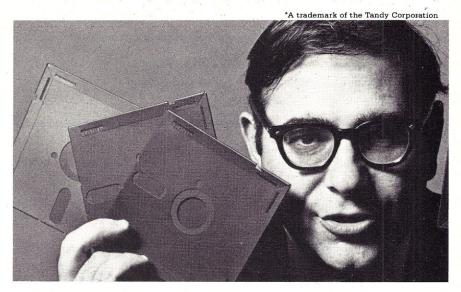
Imagine this: You don't need salesmen or advertising personnel because the customer's computer can find you without them. You don't need a high-traffic location for your store because your customers aren't depending on signs for their information. You don't need people to take the orders because the customers will tie in to your computer and fill in your computerized order blank. What you need is a product and about \$5000 worth of computer gear.

Before this idealistic new system reaches fruition we will go through the same stages of centralization and sharing of the necessary hardware. Only time will tell exactly how it will take place. We could install vending machine terminals in the supermarkets. Some arcade games now cost more than this setup would. On the other hand, there will also be neighbors and retailers who will offer to search the world for you with their systems.

Retailers today have overheads that require marking their wares up from 100 percent to 200 percent. The retail industry standard—from clothes to hard goods—is the keystone (100 percent) markup. Now, I'm not saying that there is anything wrong with that, or with the fact that jewelry is marked up even more. I'm saying that automation applied to merchandising

will allow on-line merchants (OLMs) to sell you a \$40 coat for \$22. That is fair competition, too. When you have your own system, you'll do even better than that.

So decreases in cost and trends toward distributed computing will inevitably lead the whole computer industry to a major thrust into the largest market of all, the personal market. When you think in terms of large organizations, you find varied needs that split the discussion into many different directions. One hun-



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dred million individuals, though, can be discussed as one group with similar needs and wants.

Mr. and Ms. Doe

As yet, we don't know what Mr. and Ms. Doe will require from computers, communications and their peripherals. In a free competitive market, though, they will get whatever they want. With millions of dollars at stake and with our foot in the door, it's about time we found those wants for them.

Let's examine what automated functions the consumer can use.

- On-line publishers and news services
- Active idea exchanges (usually for profit).
- Lots of simplicity and standards.

No new technology is needed to develop these systems, and some of them are in use today. There is literally more technology than we know what to do with. Simultaneously, there are approaching several dramatic advances associated with communication and information management:

• Very large scale integration (VLSI) that can put minicomputers in your pocket and word processors on a chip.

Increased rate of change.

• Increased need for the public to update their education.

• Retail terminals.

- Increased interpersonal communication.
- Society will be functionally ahead of any society that uses older methods.

We should also consider how these advances will affect:

• The government (reassessment by the public, participatory democracy).

Our culture.

- Large computer corporations.
- Copyright control.
- The third world.

Advertising.

- Taxes and enforcement effectiveness.
- Entertainment.
- Time.

QQ.

We are now facing an age of access and potential. Like every frontier that has come before, there will be many different positions to be filled and many occupations to benefit. The first to enter will probably face the most problems and the most profits and will eventually develop the most effectiveness.

Nothing is absolute; we will always have stores, sales managers, administrators and large corporations, but in the future we will have fewer of them because there will be incentives to consider other alternatives.

Conclusion

More than new technologies, we need thought and communication about our uses for today's technologies from leaders, businessmen and authors. In America, changes are made not by governmental action or mandate, but by individual choice and market support.

Most likely, the software for many of the systems described here is already available, or will be printed in magazines for public use. We need the involvement of individuals and the development of organizations (cooperation, standards and norms, establishment of values).

The bottom line is opportunity—opportunity to offer these new systems and opportunity to use them. Where there is a better way, the market will pay someone to supply it. That is one thing about our society that computers won't change.

Over the next ten years these systems will become more evident to our culture, our society, our government and Mr. and Ms. Doe. To the people involved it is here now.

00

There is literally more technology than we know what to do with.



• Electronic mail to save money, speed interaction and simplify communications.

• Automatic searches of the computers in the local area (local for low communication and transportation costs) for an idea or a product at the best quality/price ratio.

• Electronic bulletin board available to other individuals and their computers to make ideas, products and services known.

• On-line merchandising (OLM) with compiled product data bases.

• On-line original manufacturers (OLOM) for the lowest prices.

• A better business bureau, standards and trade and user groups to protect the individuals and give the system credibility.

• Distribution libraries (borrow and lend exchanges) to locate a lender of a certain thing needed only for a short time.

• Classes and round-robin discussions to stimulate your imagination and keep you up to date.

 Automated ordering of products and automated updates until those products arrive.

• Electronic funds transfer (EFT) to simplify marketing.

 Organized barter to save taxes and stimulate trade.

 Time-share services for individuals and families to balance the distributed/centralized issue and to quickly implement new features.

• Private mail (locally coded and decoded).

- Large communications networks (XTEN, ACS, SBS) to offer satellite communications, video conferencing, voice-store-and-forward and an integrated voice, data, image and text network.
- New technologies to multiply memory densities annually.
- Advanced software to develop plain-English programming and system simplicity.

Effects

We should consider some of the effects that advanced communication and automation will have on our society.

• Reduction in automobile use and possibly in cross-country distribution.

• Increase in cottage industry and self-employment.

 Personnel reductions in whitecollar departments.

Decreased retail prices.

Middleman and retailer reductions.

• Large investments in microcomputers.

Fewer middlemen, retailers and administrators will mean more persons involved in production and direct services. This means an increased national production potential and a better balance of trade. It should also mean a higher average standard of living.

Further by-products of this advanced society include:

• The practicality of temporary, ad hoc groups organized for profit.

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Open Up the SWTP 6800

A bit of minor surgery maximizes the capabilities of this popular system.

Dr. Gordon W. Wolfe Physics Department University of Mississippi Oxford, MS 38677

The SWTP 6800 microcomputer system is a versatile system, particularly well-suited for real-time data acquisition, analysis and control. However, some minor engineering shortcuts have left the machine with less than its full availability. With the addition of only two common integrated circuits and a few wires, you can maximize the capabilities of the computer and its bus.

Add a User Scratchpad

I recently developed a lowcost vectored graphics display and had just finished testing both software and hardware together. Since the display depended on an oscilloscope, it had to be refreshed many times a second through the use of the MP-T interrupt timer.

While programming the driver routine into EPROM, I realized I had no place to put the display data or a few necessary data bytes. There was no problem in RAM, but EPROM can't be changed during execution! I had no room in low memory, which contained the BASIC interpreter, and no room in middle memory, which housed the disk operating system. That left the monitor scratchpad at \$A000. But since my RT-68MX monitor uses about three-fourths of it, I was not going to fit over a hundred data bytes into a 128-byte RAM.

The solution was obviously

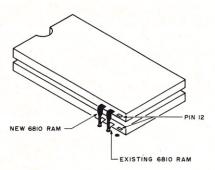


Fig. 1. Method of piggybacking the new 6810 RAM on the MP-A board.

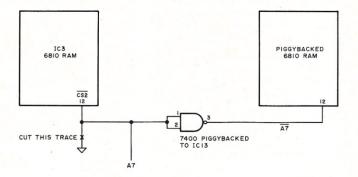


Fig. 2. Wiring the new 6810 RAM to respond to addresses \$A080-\$A0FF.

more memory. But that involves a capital outlay of at least \$100 for a 4K memory board and, since my motherboard is full, a new motherboard and power supply!

Fortunately, for only the small amount of memory I needed, there was an easier solution. I keep spares of all the major chips used in the 6800 system. including a spare 6810 RAM. By integrating this 128 × 8 memory into the system, you can obtain another 128 bytes. The logical place is at address \$A080, since the existing 6810 is at \$A000-\$A07F. The SWTP 6800-on the old MP-A card-uses incomplete address decoding, so the existing 6810 not only responds to \$A000-\$A07F, but also to \$A080-\$A0FF, \$A100-\$A17F . . . all the way up to \$BFFF. This 128-byte RAM uses 8K of memory space.

I connected pin 12 of IC3, a 6810, to address line A7. This active-low chip-select pin, tied permanently to ground, responds only when A7 is low, or for addresses \$A000-\$A07F, \$A100-\$A17F, \$A200-\$A27F, etc. Another 6810—otherwise connected identically as IC3, except for pin 12—could be configured to respond to \$A080-\$A0FF, \$A180-\$A1FF and so on.

You only need three wires and two ICs to make this change. One IC is a new 6810 RAM, which is piggybacked over the old 6810. All pins, except pin 12, are soldered over the pins of the existing 6810. The 6810s are CMOS chips, so you must observe static precautions. You should also remove the 6800 CPU and 6830 monitor ROM during this operation. Bend pin 12

out sideways, and, with a pair of cutters, cut pin 12 of the old 6810 from the PC board and bend it out sideways. Using a short piece of wire, connect address line A7 directly to pin 12 of the old 6810. (See Fig. 1.)

To make the new 6810 respond to the proper addresses, address line A7 must be inverted. Unfortunately, there are no unused gates or inverters on the MP-A card, so you must add one. A low-cost 7400 NAND gate will serve the purpose and be used later.

Piggyback the 7400 over an existing 7400, IC13, but solder down only the power and ground pins, 7 and 14. Bend the other twelve pins of the new 7400 out sideways so they do not touch each other or the board. One gate of the chip is used as an inverter by connecting address line A7 to pins 1 and 2; the gate output, pin 3, is connected to pin 12 of the new 6810. (See Fig. 2.)

Since the 6810 outputs are Tristates and since all other address and control pins are the same, the two RAMs will now not interfere with one another and will give you a full page of memory from \$A000 to \$A0FF.

Opening Up the Bus

Whenever any memory on the CPU card is accessed, the data bus drivers, IC8 and IC9, are disabled. The MP-A card contains not only the 6810 RAM, but also a 6830 monitor ROM, whether it be MIKBUG, SWTBUG or RT-68MX. To be MIKBUG-compatible, this ROM must respond to addresses from \$E000 to \$E1FF. But to include the interrupt and restart vectors, this same ROM must also respond to addresses \$FFF8 through \$FFFF. This is accomplished by incomplete decoding of addresses, so that the 1K ROM is repeated eight times from \$E000 to \$FFFF. Also, there is the 6810 RAM at \$A000.

The partial address decoding is handled by the upper half of IC16, which disables the bus when both address lines A13 and A15 are ones, or when addresses \$A000-\$BFFF or \$E000 -\$FFFF are present. The latter 8K is necessary for the interrupt vectors, but there is no reason for the 128×8 (or 256, if the mod-

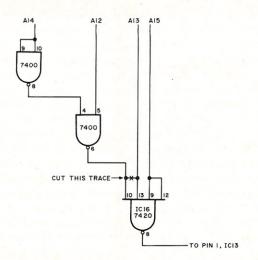


Fig. 3. Modification of MP-A board to open up addresses \$B000-\$BFFF.

ifications above are made) 6810 RAM(s) to use up 8K of memory.

With the 7400 in place over IC13, a minor change may be made to allow the data bus to carry information for addresses \$B000-\$BFFF. This is accomplished by letting IC16 disable the bus only when lines A12-A15 are hex A, E or F. That is, when A13 and A15 are high, but when A14 is low and A12 is high, do not disable the bus.

IC16 is a dual four-input NAND gate. The upper half is used as a two-input NAND on A13 and A15. There are two unused inputs. Cut the trace to pin 10 of IC16 and add wires to the piggybacked 7400 as shown in Fig. 3. Now the bus will be disabled when A13 and A15 are high (1s input to IC16). When A12 = 1 and A14 = 0, the input to pin 10 of IC16 will be zero and the NAND will produce a high output, enabling the bus.

This process allows the user to use all of memory space from \$B000 to \$DFFF, adding an extra 4K of accessibility, for a total of 12K

Open Up the Motherboard

Incomplete decoding plays a part on the SWTP MP-B motherboard as well. The I/O slots respond to addresses \$8000 to \$801F, \$8040 to \$805F, \$8080 to \$807F...up to \$9FFF. The blank spaces in between are for future expansion so that a second motherboard may be added.

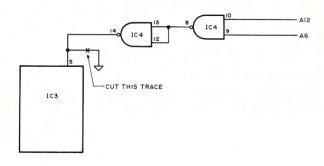
Again, there is no reason to tie up 8K of memory space for 32 bytes of memory-mapped I/O. The area from \$9000 to \$9FFF may be opened up for use by a simple expedient. On the motherboard, pin 5 of IC3 is grounded. This is a chip enable pin that must be low to permit the I/O slots to respond. If the trace to pin 5 is cut and a wire is connected from pin 5 of IC3 to address line A12 when address line A12 is zero (\$8000-\$8FFF), the I/O will work. When the line is high, as in \$9000-\$9FFF, the I/O bus will be quiet. This allows the user to place a memory

board or EPROM at this location.

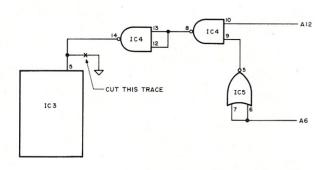
For users of the Smoke Signal Broadcasting BFD-68 floppydisk system, the above-mentioned addition of a second motherboard for more I/O slots is more difficult because the bootstrap ROM on the BFD-68 is configured in a unique way: I/O slots 0 through 7 respond to \$8000 to \$801F, and more, as stated above. The bootstrap ROM "fills in the cracks." That is it uses the unused locations \$8020 to \$803F, \$8060 to \$807F, and so on. Furthermore, the decoding for these is complete. The 1K ROM simply uses every other 32 bytes to load the disk operating system so that no additional memory is used.

There is no room for adding a second motherboard if more I/O is needed. Since the I/O takes the first 32 bytes, the disk the second 32, the I/O the next 32 and the disk the fourth 32, there is no room left all the way to \$8FFF (or \$9FFF, if the above change is not made).

If the second motherboard could be made to respond to \$8040 to \$805F, and the first motherboard not to respond to



(a) MODIFICATION TO ORIGINAL MOTHERBOARD



(b) MODIFICATION TO NEW MOTHERBOARD

Fig. 4. Rewiring motherboard so that the I/O slots will respond to a) \$8000-\$801F, b) \$8040-\$805F. Also, opening up addresses \$9000-\$9FFF.

these addresses, this would solve the problem. Fortunately, you can do this without additional ICs

Place address line A5 low for I/O and high for the DOS bootstrap. If you desire to decode address line A6 and if A6 = 0, I/O will respond to addresses \$8000 to \$801F. However, if A6 = 1, I/O will respond to addresses \$8040 to \$805F. IC4 and IC5 are quad two-input NAND and NOR gates, respectively. Between them, there are three unused gates, which may be used for

additional address decoding. We can still use the A12 line to open up the \$9000-\$9FFF addresses

The unused gates are disabled by grounding the inputs. With a sharp razor blade, cut the foils connected to IC4, pins 9 10, 12 and 13, on the bottom of the board so that each pin is unconnected. The same is true for pins 5 and 6 of IC5. Then run jumper wires from address lines A6 and A12 to these ICs and to pin S of IC3, as shown in Fig. 4. Be sure to cut the ground line foil from pin 5 of IC3, as above, on the bottom of the board. Fig. 4a shows the modification for the first motherboard to let I/O respond to \$8000-\$801F; Fig. 4b shows the modification for the second motherboard to allow I/O to go out at \$8040-\$805F.

Finally, let me caution you about opening up \$9000-\$9FFF. Users of the BFD-68 disk system should be aware that the disk drive is interfaced through a PIA that is addressed at \$9FFC. Any attempt to put a full 4K of memory into \$9000-\$9FFF will inter-

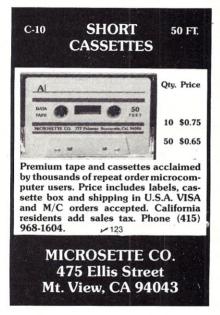
fere with this PIA, causing problems with the disk.

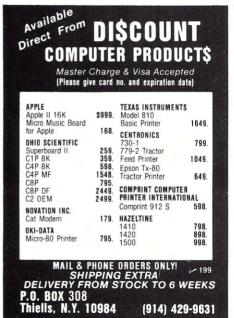
Summary

For the price of two integrated circuits and some wire, you can upgrade your SWTP 6800 in about an hour's time. This results in the addition of another 128 bytes of memory, opening up 8K of memory space and the addition of a second motherboard without interfering with the BFD-68 disk system. That's what I call cost-effective work!













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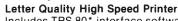
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The New CP/M: Is It Worth It?

This reviewer thinks so—and lists some reasons why.

Richard Fritzson 25 Callodine Ave. Amherst, NY 14226

igital Research has released an updated version of their popular CP/M microcomputer operating system. The old one was release 1.4; the new one is release 2.0. First-time purchasers of CP/M have no choice; only the most current release is sold. However, those who already have CP/M now have to decide whether to spend the money needed to update their system.

New Features .

CP/M 2.0 is user configurable to all types of currently available disk drives: floppies and mini-floppies, including single, double and quad density, as well as the new hard disks. If you plan to upgrade your hardware to include a different type of disk than you have now, you need the new CP/M.

Externally, CP/M 2.0 has several new conveniences. The console I/O routines now recognize the back space and delete characters on CRT terminals instead of echoing them (the rubout key still deletes and echoes). Each individual file on a disk can be marked as "read-only,"

preventing its modification, renaming or accidental erasure.

Files can also be marked as "system-files," which means only that they will not appear in a directory listing. This apparently reduces the clutter of having the standard .COM files appearing in each directory listing, which is now four columns across instead of only one.

Each CP/M disk can be shared by up to 16 users, each of whom is assigned a number; all file access is restricted to one user number at a time. This feature is convenient if you share your large, hard-disk system with others, but I don't think floppy disk users will have much use for this feature. Since every user needs his own copy of STAT, PIP, ED and all the other standard utilities, disk space disappears rapidly.

The most noticeable improvement in this version is on the inside. CP/M finally has decent random access capability for its disk files. This means that you can read or write each of up to 65,536 128-byte records, in any order, by simply giving a record number and making an I/O request. There is no need to calculate which extent the record is in, then open and position the extent before reading. There is no need to write to and allocate all of the records prior to the one you want to write.

CP/M only allocates disk space

when you actually write a new record. You can write the first and last records of an eight-million-byte file on your mini-floppy; but don't try to fill in all of the space in between.

Old vs New

If you're an assembly-language programmer who does a lot of disk I/O, then the simplified access to files and the "virtual file" facilities are a real help. But if you run mostly prepackaged software or if you write BASIC programs under an interpreter that runs under your current CP/M, then all you gain are the amenities, such as four-column directory listing and individual readonly file.

I suggest that you wait a while before purchasing an updated CP/M. Let Digital Research eliminate the bugs (there were some in the first one I tried; they're gone now), or wait until they release version 2.1.

However, don't be surprised when the next piece of software you want —whether it's a language processor such as the latest BASIC or Pascal or a system tool such as a text editor or, especially, a data base package—requires the new CP/M, or at least tempts you by promising improved performance if you have it. The assembly-language programmers who write those will be using the new file access features.

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Dial-up Directory

Communications software and the OSI C1P are the subjects of this Directory.

Frank J. Derfler Jr. PO Box 691 Herndon, VA 22070

his installment of Dial-up Directory will deal with the hardest part of computing: the software. I will review some old and new communications software and devote a special section to the telecomputing uses of the OSI C1P.

Old Software Revisited

I reviewed Leonard Garcia's Telestar program a few months ago (March 1980, p. 50). This North Star communications software has been improved and expanded. Telestar is designed specifically for the Horizon computer, but it will run on any North Star system with the proper addressing. The original program turns your computer into a smart terminal capable of saving or recording a complete telecommunications session on disk and calling it out for review, printing or retransmission.

The new version provides even greater flexibility. Incoming data can now be designated to be saved or not saved (this conserves space in both RAM and disk). Another new feature allows you to send a file to a timesharing or other system and to receive data to memory and disk. Previously, this could only be done with another Tele-

Leonard includes another program

called Telshare, which allows simultaneous use of a Horizon by a local and remote input. You can operate the system locally while another person either monitors or works along with you from a remote location. This is particularly well suited for demonstrating programs or for taking turns playing games. It also has potential for tutoring during computer-assisted instruction. Leonard includes six versions of the program to suit different RAM sizes.

This program, like Telestar, has a built-in customizing routine. Both programs are meant to be used with the standard RS-232 ports and an external acoustic modem, but Leonard supplies software listings to interface with the Potomac Micro-Magic modem board. Both programs are well documented and cost \$30. Contact Leonard E. Garcia, 3517 Herschel Rd., Dallas, TX 75219.

Another revised software package came in from The Microstuf Company in Decatur GA. Their Remote Console and Bulletin Board programs are used on the Remote North Star message system in Atlanta, (404) 939-

Remote Console is available for all North Star and most CP/M systems. This machine-language program interfaces a D. C. Haves or Potomac Micro-Magic auto-answer modem to the disk I/O routines for true autoanswer capability. It provides the automatic baud rate selection, call counter, boot-up and other functions. The standard version loads at 0100H.

Bulletin Board is a package of BA-SIC programs that provides a complete electronic bulletin board service including a help file, menu, logging, message field search, message file, program file and system operator editing functions. This means that if you have some other phone line answering arrangement, the bulletin board software is still available in BA-SIC for your use. The package costs \$30, not including various options and customizing costs.

Microstuf's XLINK and CLINK are smart terminal and file transfer programs for North Star and CP/M, respectively. They are meant for use with the D. C. Haves modem and allow transfer of files, auto-dialing and various file output and reading capabilities. These programs tie the disk, modem and computer together into one effective smart terminal package. They cost between \$25 and \$50, depending on the versions.

Documentation and utilization are important parts of any software package. The documentation for Len Garcia's Telestar is excellent. Len supplies program listings, comments and patch points, plus many practical hints on operation. The programs also have a self-patching capability in which they cue the user through changes and then save themselves on

disk in the changed version.

Microstuf's documentation is less complete, but their philosophy is different. Les Freed and Bob Strong, the Microstuf folks, work with their customers to provide a package as "precustomized" as possible. The programs written in BASIC are selfprompting and clear. The documentation is sparse, but the service is great. If you order from Microstuf, you should include the detailed specifications of your system such as addresses, memory size and keyboard/ terminal arrangement.

Talk on Your Apple

Apple computers make good terminals for data communications. Several software packages are available to meet different hardware configurations. The ultimate sparkle for a highly polished Apple comes with Bill Blue's Apple software package called ASCII Express. This package of six programs needs 48K, Applesoft in ROM, at least one disk drive and a D. C. Hayes MicroModem to run. It allows you to transfer programs and files to and from any other system.

Along with the file transfer program, Bill has included routines to make Applesoft and integer programs into textfiles, compress files for more economical transmission over longdistance phone circuits, read textfiles locally, create textfiles from blocks of binary data and operate the Apple as a terminal in uppercase and lowercase (with the Don Paymay lowercase board). The disk Bill sends is packed full. Documentation for the ASCII Express is descriptive.

This software is set for a fairly specific machine configuration, but when I demonstrated it to several local Apple users, they pointed out sections that would also be valuable to people using a communications card and external modem. Bill Blue and Craig Vaughan are the authors of the ABBS software. Bill runs the People's Message System at (714) 449-5689. The complete ASCII Express (Bill Blue, PO Box 1318, Lakeside, CA 92040) sells for \$34.95.

The people who run The Source information utility have an Apple II program specifically designed for their system format. After you bootup the program, it will dial The Source automatically (if you have a D. C. Hayes board), sign you on the system and transfer files and data between your system and The Source's Prime computers. It will work with-

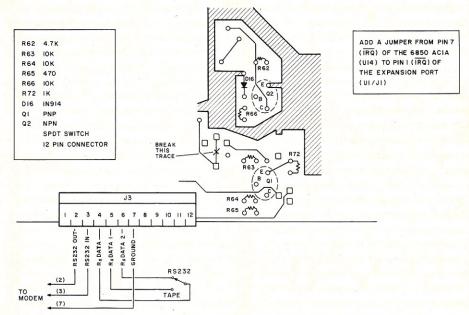


Fig. 1. Parts you must add to the OSI C1P circuit board to get RS-232 output. The transistors are not critical. A 2N2222 will work fine for the npn transistor, and a 2N2905 or similar transistor will serve for the pnp transistor. Radio Shack 276-2033 and 276-2034 will work too.

out the D. C. Hayes board, but you have to do the dialing.

Because the Apple displays fewer characters per line than most systems, a special feature that scans the incoming data and prevents the "breaking" of words at the end of a line by automatically moving the word to the next line is included. This Source Apple II Terminal Package is \$29.95 from Telecomputing Corporation of America, 1616 Anderson Rd., McLean, VA 22102.

If you don't want to buy a D. C. Hayes modem board, you can use the Apple computer as a terminal for just a few dollars. Many small enterprises are making communications boards for the Apple. A communications card used with an outboard acoustic coupler works OK. Electronic Systems makes an RS-232 card that is available as either a kit (\$42) or assembled (\$62). A program listing that comes with the card allows elementary operation as a terminal. Some patching and personalizing may be needed, so this is not a project for novices, but the price is certainly right.

Bill Hyde of San Antonio has come up with a program that is not purely for on-line telecommunications, but it sure is a convenient aid. Bill's Autodialer provides the Apple user with a listing of bulletin board, time-sharing, digital network and other telecomputing systems. You can easily change and add to all data, including remarks. You can review the listings,

numbers and comments, and (if you have a D. C. Hayes MicroModem) the system will automatically dial the number of the listing you select and turn you over to whatever communications program you may have.

The various transmission options of the D. C. Hayes board are software selected through the program, which will work on disk or tape; either version costs \$15. Bill runs the San Antonio ABBS, (512) 657-0779, or he can be reached at PO Box 12883, San Antonio, TX 78212.

OSI C1P

The OSI C1P provides economical, but versatile, computer power. Microcomputing (January 1980, p. 140) ran a review of the CIP in which the author speculated that this system could be used as a low-cost terminal for telecomputing use. He was right, but first somebody had to write the software and define the hardware changes needed. Enter Mike Carroll of Tulsa OK. Mike has provided us with the hardware changes and software listing to use the C1P as a dumb terminal. Smart terminal routines are in the works.

Any computer acting as a dumb terminal has only two jobs:

1. Any data entered by the local keyboard must be sent to a UART (universal asynchronous receiver/ transmitter), where it is converted to a string of serial bits and sent to a modem in the RS-232 format. RS-232 is a ± 12 volt signaling scheme that is the most common standard for serial transmission in the microcomputer world. In the OSI C1P the UART is a Motorola 6850. Motorola calls their chip an ACIA, which is how it is referred to in the program comments.

2. Any data received from the modem via the UART must be displayed on the screen.

Dumb terminal is an appropriate name for such a computer. After the data leaves the screen, it is gone for good. Smart terminals can save the data and recall it for later use.

On other computers, the terminal program alternately reads the keyboard and UART ports and routes the data to the right place. The OSI C1P does not work this way. It uses a polled keyboard scheme in which software loops monitor when a key is pressed and determine which one it is. Unfortunately, this means that data from the UART may go unnoticed and become lost while the monitor is working with the keyboard. This program uses the interrupt capability of the 6502 CPU to get the attention of the monitor.

The terminal program for the C1P calls the monitor routine to scan the keyboard. When a keyboard character is received, it is written to the UART through the program and the monitor is called again. This is an endless loop. When the UART receives a character in from the modem, it interrupts the keyboard polling and calls for the program routine to send the character to the screen. The keyboard scan then resumes.

Some parts and hardware changes are needed to operate the C1P as a terminal. A hardware jumper must be added so that the interrupt can reach the 6502 (see Fig. 1). This addition consists of a jumper from pin 7 of the 6850 to pin 1 of the expansion port. The C1P does not come with full RS-232 capability. The circuit board traces are present, but some parts are needed. These parts are described in some of the OSI documentation, but not clearly. The parts list and circuit diagram of Fig. 1 show where they should go. It is not a difficult modification, but one that was left to the user to keep the initial cost down.

```
OBJECT
                                                                COMMAND
                                                     'Dumb' terminal program.
M. Carroll 10 January 1980
                                                   Set IRQ vector so that our routine gets control.
                                                                LDX #$02
LDA JMP,X
STA $01C0,X
DEX
BPL VSET
                                                                                                            Copy jump command
to the IR2
vector
                                                   Reset ACIA and configure it for 7 data bits, even parity, 1 stop bit, and allow 6850 to interrupt when a character is received.
                                                                LDA #$03
STA $F000
LDA #$8D
STA $F000
                     03
00 F0
8D
00 F0
                                                                                                           reset ACIA
                                                                                                           configure ACIA
                                                   Only now do we allow IRQ's to take place (could otherwise cause loops from spurious interrupts.)
0315
                                                                                                           allow IRQ'S
                                                   Get a key from the monitor keyboard scan routine.
When a key is pressed, wait for ACIA XMIT buffer
to empty and then send key to modem.
              20 ED FE
48
AD 00 F0
29 02
F0 F9
68
8D 01 F0
D0 EF
                                                                                                          get a key
save it
get ACIA status
check XMIT ready
not ready, loop back
reload key
give to ACIA
get another key
                                                                JSR $FEED
                                           READ
                                                                         $F000
#$02
                                           RDLOOP
                                                                BEQ RDLOOP
                                                               STA $F001
BNE READ
                                                  This command is copied to the IRQ vector.
              4C 2A 03
                                                                JMP WRITE
                                                                                                           IRQ action
                                                 This routine gets control via the IRQ vector whenever the 6850 receives a character and interrupts the CPU. Since the 6850 will interrupt when the character is ready, we don't have to check the ACIA status. Pull the character from the ACIA and give it to the monitor routines to be written on the screen. Return to the interrupted routine (most likely the keyboard scan.)
                                                                                                          save reg
get char from ACIA
write it to screen
restore reg
return
```

Program listing. Polls the keyboard, sends interrupts to the CPU when the UART receives data from the modem and displays the received characters on the screen. Note that all received characters are displayed including control codes and anything else sent by remote systems.

It is important to note that even when the parts are added and the circuit trace is cut, the output voltage does not meet the full RS-232 standard. No negative voltages are used in the C1P's 6502 system, and the highest voltage available is +5 volts. Therefore, the output swing is only from 0 to +5 volts instead of the higher plus and minus swings of true RS-232.

Many modems will work with these voltages, but if your modem will not, then you can put a separate board such as the Electronic Systems TTL/RS-232 board (about \$10) between the computer and the modem. This board could use power borrowed from the modem. The C1P RS-232 modification will accept the full RS-232 voltage swing on the input.

The C1P runs at about 320 baud instead of 300 baud because of various money-saving frequency sources and dividers used. This has not been a problem in operating with Tymnet, most bulletin boards and IBM-equivalent communications equipment. The displayed line length is 24 characters, and 24 lines will fit on the screen before they move off. This is not a major drawback if the control-S or pause command is used to hold the input from a system while a note is made or the text reread.

The OSI C1P retails for about \$350. You must add a tape recorder and monitor, but the entire system could be on the air for under \$500, which is several hundred dollars under any other sort of terminal capability. Who is going to bring up the first OSI Bulletin Board System? OSI C1P users who have comments or questions can write to Mike Carroll at PO Box 2844, Tulsa, OK 74101.

Dial-up

Many different computers can be used as terminals. There are definite cost, capability and convenience trade-offs between the systems, but no matter what system you have, using your computer to communicate can open new worlds of education, information and interest.

I would like to hear your comments, questions and experiences. Tell me about hardware and software you have used for telecommunications. Send paper mail to PO Box 691, Herndon, VA 22070. Include an SASE if you want a reply. Send electronic mail to the Remote North Star (404) 939-1520 or to TCB967 on The Source. ■

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TRS Text Formatter

Modify Law and Mitchell's formatter (May '79) for TRS-80 use.

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s those of you with TRS-80s who have attempted to use Law and Mitchell's excellent "Editor/Formatter" program (Microcomputing, May 1979, pp. 26-33) already know, the program requires some alterations before it will run in your Level II machines (see Table 1).

With these changes accomplished, you sat down to do some word processing you had been putting off until you had such a program and immediately encountered

Disappointment #1

The program worked beautifully as long as you didn't insert any commas, quotes or colons in your text material. Commas, quotes and colons are, of course, string delimiters in Level II BASIC. After receiving a few EXTRA IGNORED error messages, you learned that you could at least use commas and colons if you remembered to lead off each line insertion with quote marks, and resigned yourself to using an apostrophe as a quote-marks substitute. That's the cue for

Disappointment #2

You type in a page or two of text and want to add more but don't have the time, so you decide to save it on tape. Later, you return, load the text back into memory and begin to review it. You are surprised to find that whole sentences are missing or have been reduced to a few words. No problem, you say; I'll just load the other copy (you always make at least two copies of everything). But this yields the same results. What happened?

Those commas and/or colons sprinkled throughout your text were treated as string delimiters by the PRINT#-1 statement when the data was written to tape-in spite of the leading quote marks (and with no error messages to warn you of what was happening). Now, you must choose between using civilized punctuation or being able to save text data on cassette.

Not so. The following will describe a machine-language program which is called by the "Editor/Formatter" program that

- 1. Permit you to use any printable ASCII character in your
- 2. Input/output your text data on cassette tape exactly as it was originally written.
- 3. Familiarize you in a very practical way with the seldomly used VARPTR and USR (0) functions.

Line Input Using INKEY\$

First, before I describe this program, I'll show you a way to eliminate disappointment #1 with just a few more changes and some added program lines. This is a quick modification that will fit the need of those who want to use commas, quote marks and colons but don't require their data to be saved on tape.

The fortunate users of Radio Shack Disk BASIC will recognize immediately that what we Level Ilers need is their LINE IN-PUT function. The Disk BASIC LINE INPUT statement allows the user to input a string variable, which is terminated only

```
25 L=L(M):P=1:I$="": PRINT "COMMAND ?"::GCSUB5000:PRINT:
   IFIS=""THENIS=BS:GCSUB1000:ELSEGCSUB1000:IFR<OTHEN 40
```

124 IS="":PRINT">?"; :GCSUB5000:PRINT:IFIS=""THEN2100

```
4999 REM - BUILD IS WITH INKEYS
5000 PRINT CHR$(14);
5010 A1$ = INKEYS : IF A1$ = "" THEN 5010
5020 IF A1S = CHRS(13) THEN RETURN
5030 IF A1S = CHRS(8) AND LEN(IS) = 0 THEN PRINT " ";
:PRINT A1S; : GCTC 5010 ELSE IF A1S = CHRS(8) THEN
           IS = LEFTS(IS, LEN(IS)-1) : PRINTAIS; : GCTC
5040 IF A1S = CHR$(24) AND LEN(1$) = 0 THEN 5010 ELSE
IF A1S = CHR$(24) THEN FOR I = 1 TO LEN (1$)

1 PRINT CHR$(8); NEXT; I$ = ""; GOTO 5010

5050 IF A1$ = CHR$(9) THEN A1$ =

STRING$(8 - 8*(LEN (1$)/8 - INT(LEN (1$)/8)),"")

5060 IF LEN(1$) + LEN(A1$) > 255 THEN RETURN

ELSE I$ = 1$ + A1$ : PRINT A1$; COTO 5010
           ELSE IS = IS + AIS : PRINT AIS; : GCTC 5010
```

Modification A. Changes in "Editor/Formatter" lines 25 and 124 and the addition of a new subroutine at line 5000 to provide the LINE INPUT function by using BASIC's INKEY\$ statement.

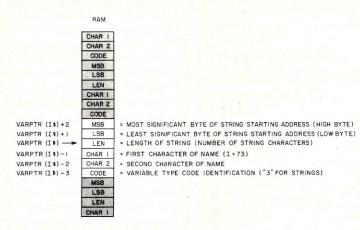


Fig. 1. VARPTR (I\$) = the memory address that contains one byte of information about I\$. Note that by incrementing or decrementing the VARPTR values, the other bytes can be accessed. Shaded areas represent the continuation of the variable table.

by a carriage return (pressing the ENTER key generates a carriage-return character).

By retyping lines 25 and 124 of the original program and adding an INKEY\$ subroutine at line 5000 (see Modification A), you can duplicate the LINE INPUT functions.

Because the familiar question mark (?) prompt generated by the BASIC INPUT statement is lost with the use of the INKEY\$ subroutine, "Command?" and ">?" are printed to take its place. I inserted the word "Command" to help me distinguish between the COMMAND and INSERT modes of the program.

If you use Modification A, when a command or text string input is required, a prompt will be displayed and the subroutine beginning at line 5000 will be entered.

Line 5000 turns on the cursor. The program then loops in line 5010 until you press a key. When you do, A1\$ is set equal to the value of this character. Line 5020 checks to see if the key you pressed was ENTER, and if so, it will return with I\$.

Lines 5030 and 5040 reposition the cursor and prevent wiping out your prompt symbol when the control functions of back space (Arrow Left) and clear-to-the-beginning-of-line (Shift, Arrow Left) are used. Line 5050 enables the TAB function (Arrow Right).

Finally, in line 5060, after a check is made to keep I\$ from exceeding 255 characters, A1\$ is concatenated (love that word!), or added, to I\$, displayed on the monitor, and the GOTO 5010 causes the whole process to repeat. Thus, I\$ grows character by character until you terminate it with the ENTER key.

Machine-Language Mod

As mentioned, the INKEY\$ subroutine, though useful for some, doesn't put us any closer to being able to save/load delimited string data. However, Program 1 (PGM 1) is the source listing of a machine-language program that can be placed in high "protected" memory to enable the "Editor/Formatter" to work as Messrs. Law and Mitchell intended.

If you're not familiar with assembly-language source code or machine-language instructions, don't be discouraged. Just make the changes to the original program lines and type in the new program and DATA lines in the Modification B listing.

Thereafter, when you CLOAD the "Editor/Formatter" program and enter RUN, the machine-language code contained in the DATA lines will be POKEd into memory and the BASIC program/ DATA lines involved in this POKEing will be automatically deleted, so they don't take up memory space.

Modification B

Line 1. Except for the CLEAR 4500 and UN = 1 statements, original line 1's function was to set certain of the program variables to zero. Because Level II BASIC does this for us each time we enter RUN, only these two statements were saved and moved to line 2 to free line 1 as a "jumping off" place.

The GOSUB 4000 causes a branch to the subroutine that set up the USR(0) entry address,

installs PGM 1 into memory and prints a message to video reminding you to delete line 1. When control returns to line 1, lines 4000 through 4080 are deleted to regain memory space. The execution of this last instruction puts you back into the BASIC COMMAND mode with the message printed by the subroutine still displayed.

A better way to accomplish the above would be to put the loading subroutine at the very beginning of the main program. With all lines contiguous, it could delete itself completely. But what a job it would be to clear enough room to do this with the "Editor/Formatter"!

Line 25. The original INPUT I\$ of line 25 is replaced by the statements beginning with PRINT "COMMAND?" and ending with AA% = USR(0). PRINT "COMMAND ?" is our prompt symbol.

AA% = VARPTR(I\$) sets AA% equal to the decimal address where BASIC keeps its information about I\$-its variable-type identification code, name, length and the memory address where the I\$ characters are actually stored. If you think of VARPTR(I\$) as pointing to the I\$ place in BASIC's "Table of

- 1. Change all PRINT commands in lines 1200 through 1216 to LPRINT to enable line printing.
- 2. Replace the statement PRINT SPC(K) in line 1206 with LPRINT STRING\$ (K,CHR\$(32)) to gain the benefit of the Formatter's random-insertion-of-spaces routine.
- 3. Rewrite lines 700 through 781 for cassette tape input/output.
- 4. Change the Formatter control character in line 4 from G\$ = "\" to G\$ = "t" (or other character of your choice), because the TRS-80 character set doesn't include a backslash.
- 5. Change all references to RND(1) to RND(0).

Table 1. Minimal changes required to run the "Editor/Formatter" program in TRS-80 Level II BASIC.

```
Program 1. Assembly-language source listing in Zilog mnemonics.
               00110 ;* "LINEIN" - ROUTINE TO DUPLICATE THE LINE INPUT
               00120 ;* FUNCTION OF DISK BASIC AND PROVIDE TAPE SAVE/
               00130 ;* LCAD FCR STRING DATA CONTAINING DELIMITERS.
               00140 ;*
               00150 ;*
                              L. H. DANIELS
                             MAY 3, 1979
               00160 :*
               00170 ;**
                                            ************
               00180
7DB5
               00190
                              CRG
               00200 BEGIN
                                      HL, (VARPTR) ; GET POINTER ADDR
7DB5 2A8E7E
                             LD
                                                   DE POINT TO STRNG STORE
7DB8 11907E
               00210
                              LD
                                      DE, STRING
7DBB AF
               00550
                              XCR
                                                   CLEAR
7DBC
               00230
                              LD
                                      (HL) A
                                                   MAKE STRING LEN O
                              INC
7DBD
     23
               00240
                                      HL
                                                      AND PUT ADDR OF
7DBE
     73
               00250
                              LD
                                      (HL) . E
                                                      STRING STORE INTO
                              INC
7DBF
     23
               00260
                                      HI.
                                                      BASIC PGM'S PCINTER
7DC0 72
               00270
                                      (HL),D
                                                      TC STRING
                              LD
7DC1 2B
               00280
                              DEC
                                                   SADJ TO POINT TO
```

7DC0 0D	00000	DEC	ut	. ADDD OF STRING LEN
7DC2 2B	00290	DEC	HL	ADDR OF STRING LEN
7DC3 3E0E	00300	LD	A, OEH	CURSOR BYTE
7DC5 CDOD7E	00310	CALL	DISPLY	TURN ON CURSOR
7DC8 D5		PUSH		SAVE
7DC9 CD2B00	00330 AGAIN	CALL	SBH	KEYBRD SCAN
7DCC B7	00340	CR	A	
7DCD 28FA	00350	JR	Z, AGAIN	REPEAT IF NO CHARACTER
7DCF D1	00360	PCP	DE	RESTORE
7DDO FEOD	00370	CP	ODH	CARRIAGE RETURN ?
7DD2 2839	00380	JR	Z.DI SPLY	; YES, DISPLAY & RETURN
7DD4 FE01	00390	CP	1	BREAK KEY ?
7DD6 C8		RET	ż	; YES, RETURN
	00400			
7DD7 FE08	00410	CP	8	BACKSPACE ?
7DD9 2820	00420	JR	Z, CNEBK	; YES, BACKUP CURSOR
7DDB FE18	00430	CP	18H	CANCEL ?
7DDD 2819	00440	JR	Z. POLYBK	; YES, CLR LINE
7DDF FE09	00450	CP	9	;TAB?
7DE1 2830	00460	JR	Z, TAB	; YES, GC TAB
7DE3 FE20	00470	CP	20H	; I GNORE ALL OTHER
7DE5 38E1	00480	JR	C.REPEAT	; CONTROL CHARACTERS
7DE7 CDEE7D		CALL	BUILD	ADD CHAR TO STRING
7DEA 20DC	00500	JR	NZ, REPEAT	TIP LEW 233 GC FCR MCRE
7DEC 180D	00510	JR	CNEBK	; IF > 255 BACK UP CNE
7DEE 12	00520 BUILD	LD	(DE),A	STORE CHARACTER
7DEF CDOD7E		CALL	DISPLY	; AND DISPLAY
7DF2 13	00540	INC	DE	BUMP PCINTER
7DF3 34	00550	INC	(HL)	JADD 1 TO STRING LEN
7DF4 7E	00560	LD	A,(HL)	COMPARE STRING LEN
7DF5 FEFF	00570	CP	OFFH	; TC MAX CF 255
7DF7 C9	00580	RET		200
7DF8 46	00590 POLYBK	-	B, (HL)	# OF BACKSPACES INTO B
7DF9 1802	00600	JR	ZEROCK	of Endablinds INTO B
7DFB 0601	00610 CNEBK		B, 1	1 FOR 1 BACKSPACE
7DFD 7E				
7DFE FEOO	00620 ZEROCK 00630	LD CP	A,(HL)	CHECK FOR STRING LEN
				; EQUAL TO ZERO
7E00 28C6	00640	JR	Z, REPEAT	GO IF YES
7E02 3E08	00650 BKSPC	LD	A,8	BACKSPACE CNTRL INTO A
7E04 CDOD7E		CALL		; DI SPLAY
7E07 1B	00670	DEC	DE	ADJUST STRING STORAGE
7E08 35	00680	DEC	(HL)	; AND STRG LEN FOR BKSP
7E09 10F7	00690	DJNZ	BKSPC	REPEAT FOR VALUE IN B
7E0B 18BB	00700	JR	REPEAT	GO FOR ANOTHER CHAR
7EOD D5.	00710 DISPLY	PUSH	(HL) BKSPC REPEAT DE	SAVE
7E0E CD3300		CALL	33H	BASIC ROM DISPLY ROUTNE
7E11 D1	00730	POP	DE	RESTORE
7E12 C9	00740	RET	DE	7112310112
7E13 7E	00750 TAB		A, (HL)	STRING LEN INTO A REG
7F14 D608	00760 TAB1		8	STITING BEN INTO II III
7E14 D608	00760 IABI			; JUMP IF < 8
7E16 3802	00770	JR	C,GO	
7E18 18FA	00780	JR	TAB1	; JUMP IF > 8
7E1A ED44	00790 GC	NEG		MAKE DIFF POSITIVE
7E1C 3C	00800	INC	A	ADD 1
7E1D 47	00810	LD	B,A	SPACES TO TAB INTO B
7E1E 3E20		LD	A,20H	SPACE CHAR INTO A
	00820 TAB2			
7E20 CDEE7D		CALL	BUILD	ADD TO STRING STORAGE
	00830	CALL		; ADD TO STRING STORAGE
7E23 28D6	00830 00840	CALL JR	Z, ONEBK	;ADD TO STRING STORAGE ;JUMP IF STRING LEN=255
7E23 28D6 7E25 10F7	00830 00840 00850	CALL JR DJNZ	Z,ONEBK TAB2	;ADD TO STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B
7E23 28D6	00830 00840 00850 00860	CALL JR	Z, ONEBK	;ADD TO STRING STORAGE ;JUMP IF STRING LEN=255
7E23 28D6 7E25 10F7	00830 00840 00850 00860 00870 #	CALL JR DJNZ JR	Z,ONEBK TAB2 REPEAT	;ADD TO STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B
7E23 28D6 7E25 10F7	00830 00840 00850 00860 00870 00880 ;BEGIN	CALL JR DJNZ JR	Z,ONEBK TAB2 REPEAT	;ADD TO STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B
7E23 28D6 7E25 10F7 7E27 189F	00830 00840 00850 00860 00870 00880 ;BEGIN 00890 ;	CALL JR DJNZ JR TAPE WRIT	Z,ONEBK TAB2 REPEAT TE ROUTINE	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F	00830 00840 00850 00860 00870; 00880; BEGIN 00890; 00900 WRITE	CALL JR DJNZ JR TAPE WRIT	Z,ONEBK TAB2 REPEAT TE ROUTINE	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01	00830 00840 00850 00860 00870; 00880; BEGIN 00890; 00900 WRITE	CALL JR DJNZ JR TAPE WRIT	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG)	JADD TC STRING STORAGE JUMP IF STRING LEN=255 JREPEAT FOR VALUE IN B JGO FOR ANOTHER CHAR JFLAG VALUE INTO A JIF = 1
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810	00830 00840 00850 00860 00870; 00880; BEGIN 00890; 00900 WRITE 00910 00920	CALL JR DJNZ JR TAPE WRIT	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG) 1 Z,WRITE1	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02	00830 00840 00850 00860 00870 00880 ;BEGIN 00890 ; 00900 WRITE 00910 00920 00930	CALL JR DJNZ JR TAPE WRITE LD CP JR CP	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG) 1 Z,WRITE1 2	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E	00830 00840 00850 00860 00870 00880 ;BEGIN 00890 ; 00900 WRITE 00910 00920 00930 00940	CALL JR DJNZ JR TAPE WRIT LD CP JR CP JR	Z, ONEBK TAB2 REPEAT TE ROUTINE A, (FLAG) 1 Z, WRITE1 2 Z, UBER	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN OFF CASSTT & RET
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01	00830 00840 00850 00860 00870 00880 ;BEGIN 00890 ; 00900 WRITE 00910 00920 00930 00940 00950	CALL JR DJNZ JR TAPE WRITE LD CP JR CP	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG) 1 Z,WRITE1 2	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E	00830 00840 00850 00860 00870 00880 ;BEGIN 00890 ; 00900 WRITE 00910 00920 00930 00940	CALL JR DJNZ JR TAPE WRIT LD CP JR CP JR	Z, ONEBK TAB2 REPEAT TE ROUTINE A, (FLAG) 1 Z, WRITE1 2 Z, UBER	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN OFF CASSTT & RET
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01	00830 00840 00850 00860 00870 00880 ;BEGIN 00890 ; 00900 WRITE 00910 00920 00930 00940 00950	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD LD	Z, ONEBK TAB2 REPEAT TE ROUTINE A, (FLAG) 1 Z, WRITE1 2 Z, UBER A, 1	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F	00830 00840 00850 00860 00870 ; 00880 ;BEGIN 00890 ; 00900 WRITE 00910 00920 00930 00940 00950 00960	CALL JR DJNZ JR TAPE WRIT LD CP JR CP JR LD LD LD	Z, ONEBK TAB2 REPEAT TE ROUTINE A, (FLAG) 1 Z, WRITE1 2 Z, UBER A, 1 (FLAG), A	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1
7E23 28D6 7E25 10F7 7E27 189F 7E27 189F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF	00830 00840 00850 00860 00870; 00880; BEGIN 00890; 00900 WRITE 00910 00920 00930 00930 00940 00950 00960 00970	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD LD LD LD XOR CALL	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702	00830 00840 00850 00860 00870 00880 ;BEGIN 00890 ; 00900 WRITE 00910 00920 00930 00940 00950 00960 00970 00980 00990	CALL JR DJNZ JR TAPE WRIT LD CP JR CP JR LD LD LD XOR CALL CALL	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E	00830 00840 00850 00860 00870 00880 ;BEGIN 00890 ; 00900 WRITE 00920 00930 00940 00950 00960 00970 00980 00990 01000 WRITE1	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD LD LD XOR CALL CALL LD	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR)	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E43 46	00830 00840 00850 00860 00870 00880	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD LD LD XOR CALL CALL LD LD	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) B,(HL)	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E43 46 7E44 23	00830 00840 00850 00860 00870 00880 JEEGIN 00990 00910 00920 00930 00930 00940 00950 00960 00970 00980 00990 01000 WRITE1 01010 01020	CALL JR DJNZ JR TAPE WRITE LD CP JR LD LD LD XOR CALL LD L	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) HL	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E43 46 7E44 23 7E45 5E	00830 00840 00850 00860 00870 00880 00990 00910 00920 00930 00940 00950 00960 00970 00980 00990 01000 WRITE1 01010 01020 01030	CALL JR DJNZ JR TAPE WRITE LD CP JR LD LD LD XOR CALL LD L	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) B,(HL) HL E,(HL)	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E43 46 7E44 23 7E45 5E 7E46 23	00830 00840 00850 00860 00870 00880	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) B,(HL) HL E,(HL) HL	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E39 AF 7E39 CD1202 7E30 CD8702 7E40 2A8E7E 7E44 23 7E45 5E 7E46 23 7E47 56	00830 00840 00850 00860 00870 00880	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) B,(HL) HL D,(HL)	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN OFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP ;STRING ADDR INTO DE
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E43 46 7E44 23 7E45 5E 7E46 23 7E47 56 7E48 1A	00830 00840 00850 00860 00870 00880	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) HL,(VARPTR) HL D,(HL) A,(DE)	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP ;STRING ADDR INTO DE
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E44 23 7E45 5E 7E46 23 7E47 56 7E48 1A 7E49 13	00830 00840 00850 00860 00870 00880	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) B,(HL) HL E,(HL) HL D,(HL) A,(DE) DE	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP ;STRING ADDR INTO DE ;CHAR TO QUTPUT INTO A ;BUMP
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E43 46 7E44 23 7E45 5E 7E46 23 7E47 56 7E48 1A 7E49 13 7E4A CD6402	00830 00840 00850 00860 00870 00880	CALL JR DJNZ JR TAPE WRITE LD CP JR LD LD LD LD LD LD LD INC CALL	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) B,(HL) HL E,(HL) HL D,(HL) A,(DE) DE 264H	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP ;STRING ADDR INTO DE ;CHAR TO QUTPUT INTO A ;BUMP ;QUTPUT TC TAPE
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E44 23 7E45 5E 7E46 23 7E47 56 7E48 1A 7E49 13 7E4A CD6402 7E4D 10F9	00830 00840 00850 00860 00870 00880	CALL JR DJNZ JR TAPE WRITE LD CP JR LD LD LD LD LD LD LD INC CALL LD I	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) B,(HL) HL E,(HL) HL D,(HL) A,(DE) DE 264H WRITE2	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP ;STRING ADDR INTO DE ;CHAR TO QUTPUT INTO A ;BUMP ;QUTPUT TC TAPE ;REPEAT FOR LEN CF STRNG
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E39 AF 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E44 23 7E45 5E 7E46 23 7E47 56 7E48 1A 7E49 13 7E4A CD6402 7E4D 10F9 7E4F 3E0D	00830 00840 00850 00860 00870 00880	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD	Z,ONEBK TAB2 REPEAT IE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) B,(HL) HL D,(HL) HL D,(HL) A,(DE) DE 264H WRITE2 A,ODH	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN OFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP ;STRING ADDR INTO DE ;CHAR TO QUTPUT INTO A ;BUMP ;QUIPUT TC TAPE ;REPEAT FOR LEN OF STRNG ;CARRIAGE RET INTO A
7E23 28D6 7E25 10F7 7E27 189F 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E44 23 7E44 23 7E45 5E 7E46 23 7E47 56 7E48 1A 7E49 13 7E4A CD6402 7E4D 10F9 7E4F 3E0D 7E51 CD6402	00830 00840 00850 00860 00870 00880 JBEGIN 00890 00910 00920 00930 00940 00950 00960 00970 00980 00990 01000 WRITE1 01010 01020 01030 01040 01050 01060 WRITE2 01070 01080 01090 01100 01110	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) HL,(VARPTR) HL D,(HL) HL D,(HL) A,(DE) DE 264H WRITE2 A,ODH 264H	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP ;STRING ADDR INTO DE ;CHAR TO QUTPUT INTO A ;BUMP ;QUTPUT TC TAPE ;REPEAT FOR LEN CF STRNG ;CARRIAGE RET INTO A ;OUTPUT TC TAPE
7E23 28D6 7E25 10F7 7E27 189F 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E3A CD1202 7E3D CD8702 7E3D CD8702 7E40 2A8E7E 7E44 23 7E45 5E 7E46 23 7E47 56 7E48 1A 7E49 13 7E4A CD6402 7E4D 10F9 7E4F 3E0D 7E51 CD6402 7E54 0610	00830 00840 00850 00860 00870 00880 JBEGIN 00890 00910 00920 00930 00940 00950 00960 00970 00980 00990 01000 WRITE1 01010 01020 01030 01040 01050 01060 WRITE2 01070 01080 01090 01100 01110	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) B,(HL) HL E,(HL) HL D,(HL) A,(DE) DE 264H WRITE2 A,ODH 264H B,10H	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP ;STRING ADDR INTO DE ;CHAR TO QUTPUT INTO A ;BUMP ;QUTPUT TC TAPE ;REPEAT FOR LEN CF STRNG ;CARRIAGE RET INTO A ;OUTPUT TC TAPE ;OUTPUT 16 ZEROS
7E23 28D6 7E25 10F7 7E27 189F 7E29 3A907F 7E2C FE01 7E2E 2810 7E30 FE02 7E32 282E 7E34 3E01 7E36 32907F 7E3A CD1202 7E3D CD8702 7E40 2A8E7E 7E44 23 7E44 23 7E45 5E 7E46 23 7E47 56 7E48 1A 7E49 13 7E4A CD6402 7E4D 10F9 7E4F 3E0D 7E51 CD6402	00830 00840 00850 00860 00870 00880 JBEGIN 00890 00910 00920 00930 00940 00950 00960 00970 00980 00990 01000 WRITE1 01010 01020 01030 01040 01050 01060 WRITE2 01070 01080 01090 01100 01110	CALL JR DJNZ JR TAPE WRITE LD CP JR CP JR LD	Z,ONEBK TAB2 REPEAT TE ROUTINE A,(FLAG) 1 Z,WRITE1 2 Z,UBER A,1 (FLAG),A A 212H 287H HL,(VARPTR) HL,(VARPTR) HL D,(HL) HL D,(HL) A,(DE) DE 264H WRITE2 A,ODH 264H	;ADD TC STRING STORAGE ;JUMP IF STRING LEN=255 ;REPEAT FOR VALUE IN B ;GO FOR ANOTHER CHAR ;FLAG VALUE INTO A ;IF = 1 ; WRITE TAPE ;IF = 2 ; TURN CFF CASSTT & RET ;SET FLAG ; EQUAL TC 1 ;CLEAR ;TURN ON CASSETE ;WRITE LEADER ;ADDR STRNG PNTR IN HL ;STRING LEN INTO B ;BUMP ;STRING ADDR INTO DE ;CHAR TO QUTPUT INTO A ;BUMP ;QUTPUT TC TAPE ;REPEAT FOR LEN CF STRNG ;CARRIAGE RET INTO A ;OUTPUT TC TAPE

Variable Listings," it will help to make this more understandable (see Fig. 1).

PGM 1 needs the address of I\$'s "Table Listing." So, VAR-PTR (I\$) is converted to two decimal numbers, one equal to the high byte and one equal to the low byte of the corresponding value of VARPTR(I\$)'s address in hexadecimal (hex) and POKEd into two consecutive spots in memory where PGM 1 "knows where to look for them" by:

POKE 32399,INT(AA%/256):POKE32398, 256*(AA%INT(AA%/256)).

The statement, AA% = USR(0), is the signal to BASIC to take a rest and turn control over to PGM 1. To use the USR(0) function, you must first tell BASIC where to jump by POKEing the entry address of your machine-language program into RAM locations 16526 and 16527, again, as two decimal numbers that respectively equal the low and high bytes of the program entry address in hex. This is done for you during "Editor/Formatter" initialization by line 4000.

If the above seems a little complicated, it's only because it is. However, as with many other things, the more you use it the easier it becomes to understand and apply.

PGM 1

Now that the USR (0) has taken us to PGM 1, let's talk for a moment about what goes on up there at the speed of light.

Basically, the "front end" of PGM 1 does the same job as the INKEY\$ subroutine, i.e., manages the cursor position and puts your string together character by character. But, it's where this string is stored that's different.

Remember that PGM 1 is on its own. BASIC isn't moving things around to make room for a string that has grown too long to fit the initial space allotted it, or any of the hundred-and-one other "housekeeping" chores we can take for granted with BASIC on the job. Instead, that-which-is-to-become I\$ is built and saved in a special storage area labeled, appropriately enough, "STRING."

When you push ENTER, which signals the end of your string input and calls for a return to BASIC, PGM 1 first places the beginning address of its string storage space into BASIC's "Table Listing" for I\$. In this way, we cause BASIC to "forget" the old location of I\$ and to look for it instead in PGM 1's string storage area.

What about I\$ length? As your string characters were added (or deleted), PGM 1 kept a tally at the VARPTR (I\$) location. Hence, this information is already in place even before insertion of the I\$ "pseudo address," which completes the "Table Listing" and provides BASIC with everything it needs to know about I\$.

More on Mod B

Line 124. Here, your text strings are input into the "Editor/Formatter." Interaction with PGM 1 to accomplish this is the same as in line 25.

Lines 700 through 791. BASIC and PGM 1 routines are both used to save and load program variables. BASIC's PRINT #-1 and INPUT # - 1 are for numeric values and PGM 1's WRITE and READ are for string values.

Because your text data is stored in the L\$(n) array, to save it, VARPTR (L\$(n)) is passed along to PGM 1 (just as it was for I\$). Each element of the array is located in this fashion and subsequently transcribed.

During a load operation, I\$ is repeatedly formed in PGM 1's string storage space, using the tape data as a source. Then each element of the L\$(n) array is, in turn, set equal to the I\$.

Note that lines 711 and 771 can be shortened to:

711 FORI = 0TO59:INPUT#-1,L(I),F(I):NEXT 771 FORI = 0TO59:PRINT#-1,L(I),F(I):NEXT This will gain some extra memory space. I chose the longer form to help speed up cassette I/O operations.

User Instructions

The only new instruction you have to remember is to answer the MEMORY SIZE ? question with 32180. This protects PGM 1 from destruction by BASIC.

Also, don't be surprised when you press the BREAK key and

7E57 CD6402	01140	CALL	264H	3 AS DATA SPACERS
7E5A 10FA	01150	DJNZ	WRITE3	SYNC BYTE VALUE INTO A
7ESC 3EA5	01160	LD	A, OA5H	CUTPUT TO TAPE
7E5E CD6402	01170	CALL	264H	COLFOI TO THEE
7E61 C9	01180	RET	1F8H	TURN OF CASSETTE
7E62 CDF801 7E65 C9	01190 UBER 01200	RET	1101	TOTAL OF CHOOSELLE
/E03 CY	01210 ;	REI		
To the second second	01220 ; BEGIN	TAPE REA	AD ROUTINE	
The same	01230 ;			
7E66 3A907F	01240 READ	LD	A, (FLAG)	FLAG VALUE INTO A
7E69 FE01	01250	CP	1	; IF = 1
7E6B 280D	01260	JR	Z, READ1	; JUMP TO TAPE READ
7E6D FE02	01270	CP	2	; IF = 2
7E6F 28F1	01280	JR	Z, UBER	TURN CFF CASSETTE & RET
7E71 3E01	01290	LD	A, 1	SET FLAG VALUE
7E73 32907F	01300	LD	(FLAG),A	; EQUAL TO 1
7E76 AF	01310	XCR	A	CLEAR TURN ON CASSETTE
7E77 CD1202 7E7A 2A8E7E	01320 01330 READ1	LD	212H	JADDR STRNG PNTR IN HL
7E7D 11907E	01340 READI	LD	DE, STRING	STRNG STORE ADDR IN DE
7E80 CD9602	01350	CALL	296H	FIND SYNC BYTE
7E83 CD3502	01360 READ2	CALL	235H	READ ONE BYTE
7E86 FEOD	01370	CP	ODH	CARRIAGE RETURN SIGNAL?
7E88 C8	01380	RET	Z	; YES, RETURN TO BASIC
7E89 12	01390	LD	(DE),A	PLACE CHAR INTO STORAGE
7E8A 34	01400	INC	(HL)	ADD ONE TO STRING LEN
7E8B 13	01410	INC	DE	BUMP STORGE POINTER
7E8C 18F5	01420	JR	READ2	GC FOR MORE
0002	01430 VARPTR		2	
0100	01440 STRING		256	
0001	01450 FLAG	DEFS	256	
0001 0000	01450 FLAG 01460			
0001	01450 FLAG 01460	DEFS		
0001 0000 00000 TOTAL E READ2 7E83	01450 FLAG 01460	DEFS		
0001 0000 00000 TOTAL E READ2 7E83 READ1 7E7A	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE3 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE TAB 7E13	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE TAB 7E13 POLYBK 7DF8	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE TAB 7E13 POLYBK 7DF8 CNEBK 7DFB	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE3 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE TAB 7E13 POLYBK 7DFB AGAIN 7DC9	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE TAB 7E13 POLYBK 7DF8 CNEBK 7DFB	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE TAB 7E13 POLYBK 7DF8 CNEBK 7DF8 AGAIN 7DC9 REPEAT 7DC8	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE TAB 7E13 POLYBK 7DF8 CNEBK 7DFB AGAIN 7DC9 REPEAT 7DC8 DISPLY 7E0D	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE TAB 7E13 POLYBK 7DF8 CNEBK 7DF8 CNEBK 7DF8 CNEBK 7DF8 CNEBK 7DF8 GAGAIN 7DC9 REPEAT 7DC8 DISPLY 7E0D STRING 7E90	01450 FLAG 01460	DEFS		
0001 0000 00000 TCTAL E READ2 7E83 READ1 7E7A READ 7E66 WRITE3 7E56 WRITE2 7E48 UBER 7E62 WRITE1 7E40 FLAG 7F90 WRITE 7E29 TAB2 7E1E GO 7E1A TAB1 7E14 BKSPC 7E02 ZEROCK 7DFD BUILD 7DEE TAB 7E13 POLYBK 7DF8 CNEBK 7DF8 CNEBK 7DF8 CNEBK 7DF8 GNEPEAT 7DC9 REPEAT 7DC8 DISPLY 7E0D STRING 7E90 VARPTR 7E8E	01450 FLAG 01460	DEFS		

Modification B. Changes in the "Editor/Formatter" to enable the LINE INPUT function and allow cassette I/O of delimited strings. This modification automatically loads machine-language Program 1 during the initialization process.

```
1 GCSUB4000: DELETE4000-4048
2 CLEAR4500:UN=1:Q=60:DIMF(Q),B(Q),L(Q),L$(Q)
25 L=L(M):P=1:1$=B$:PRINT"CCMMAND ?";:AAZ=VARPTR(I$):PCKE32399,
   INT(AA%/256):POKE32398,256*(AA%/256-INT(AA%/256)):
   AA%=USR(0):GCSUB1000:IFR<OTHEN40
124 IS="":PRINT"?>";:AA%=VARPTR(IS):PCKE32399,INT(AA%/256):
    PCKE32398,256*(AA%/256-INT(AA%/256)):AA%=USR(0):
    IFIS=""THEN2100
700 ' TAPE LOAD ROUTINE
```

```
710 PRINT"READY TAPE": INPUT"PRESS ENTER WHEN READY ... "; R$
711 FCRI=OTC59STEP10:INPUT#-1,L(I),L(I+1),L(I+2),L(I+3),L(I+4),
    L(I+5),L(I+6),L(I+7),L(I+8),L(I+9),F(I),F(I+1),F(I+2),
    F(I+3),F(I+4),F(I+5),F(I+6),F(I+7),F(I+8),F(I+9):NEXTI
712 INPUT#-1.UN
714 PCKE16526,102:PCKE16527,126:PCKE32656,0: 'CASSETTE CN SIGNAL
716 FCRI=1TCUN-1
718 IS="": AA%=VARPTR(IS): PCKEAA%+1,144: PCKEAA%+2,126
720 PCKE32398,256*(AA%/256-INT(AA%/256));PCKE32399,INT(AA%/256)
722 AA%=USR(0):L$(I)=I$:NEXTI
724 PCKE32656,2:AA%=USR(0): CASSETTE CFF SIGNAL
744 U=L(0):UN=F(0):M=U
746 FCRI=1TCN:B(F(I))=I:NEXT:B(U)=0:B(UN)=0:F(0)=0:B(0)=0
748 L(0)=0:PCKE16526,181:PCKE16527,125: 'RESTORE LINE INPUT
749 GCTC25
750 ' TAPE SAVE ROUTINE
760 PRINT"READY TAPE": INPUT"PRESS ENTER WHEN READY ... "; R$
765 L(0)=U:F(0)=UN
770 FCRI = 0TC59STEP10
771 PRINT#-1,L(I),L(I+1),L(I+2),L(I+3),L(I+4),L(I+5),L(I+6),
    L(I+7),L(I+8),L(I+9),F(I),F(I+1),F(I+2),F(I+3),F(I+4),
    F(I+5),F(I+6),F(I+7),F(I+8),F(I+9):NEXTI
772 PRINT#-1,UN
774 PCKE16526,41:PCKE16527,126:PCKE32656,0: CASSETTE CN
776 FCRI=1TCUN-1
778 AAX=VARPTR(L$(I)):PCKE32398,256*(AAX/256-INT(AAX/256))
780 PCKE32399, INT(AA%/256): AA%=USR(0): NEXTI
782 PCKE32656,2:AA%=USR(O): CASSETTE CFF SIGNAL
790 PCKE16526,181: PCKE16527,125: 'RESTORE LINE INPUT
791 GCTC25
4000 PCKE16526, 181: PCKE16527, 125: RESTORE
4010 FCRI=32181TC32397:READA:PCKEI,A:NEXT
4020 CLS:PRINT"TC RUN ** EDITOR/FORMATTER **"
4025 PRINT: PRINTTAB(5)"FIRST ENTER ==> DELETE 1"
4026 PRINTTAB(5)"THEN, ENTER ==> RUN": RETURN
4027
    · OBJECT CODE FOR LINE INPUT FUNCTION
4028
4029 '
4030 DATA 42,142,126,17,144,126,175,119,35,115,35,114,43,43,62
4031 DATA 14,205,13,126,213,205,43,0,183,40,250,209,254,1,200
4032 DATA 254,8,40,36,254,24,40,29,254,9,40,52,254,13,40
4033 DATA 42,254,32,56,223,205,238,125,32,218,24,13,18,205,13
4034 DATA 126,19,52,126,254,255,201,70,24,2,6,1,126,254,0,40
4035 DATA 196,62,8,205,13,126,27,53,16,247,24,185,213,205,51,0
4036 DATA 209,201,126,214,8,56,2,24,250,237,68,60,71,62,32,205
4037 DATA 238,125,40,214,16,247,24,157,58,144,127,254,1,40,16
4038 DATA 254,2,40,46,62,1,50,144,127,175,205,18,2,205,135,2
4040 DATA 42,142,126,70,35,94,35,86,26,19,205,100,2,16,249,62
4042 DATA 13,205,100,2,6,10,175,205,100,2,16,250,62,165,205
4044 DATA 100,2,201,205,248,1,201,58,144,127,254,1,40,13,254,2
4046 DATA 40,241,62,1,50,144,127,175,205,18,2,42,142,126,17
```

4048 DATA 144,126,205,150,2,205,53,2,254,13,200,18,52,19,24,245

get the message "NOT A COM-MAND" if you were in line 25, or a blank text line if you were in 124, instead of the BREAK AT message. Simply tap the BREAK key twice in quick succession. The first tap gets you out of PGM 1; the second gets you out of execute mode before PGM 1 can be entered again.

Print Driver

As you may have noticed, not all of the protected memory is taken up by PGM 1. It ends at decimal address 32656 (7F90H). The reason for this is that I use the TRS-232 Printer Interface (a fine piece of hardware with excellent documentation and software provided, from Small Systems Hardware, Newbury Park CA). These remaining 100 plus bytes are, therefore, taken up with a print driver routine. You can put your keyboard debounce program, blinking cursor routine or whatever you wish in its place.

Conclusion

I hope you have as much pleasure in using the modified "Editor/Formatter" as I had in writing the mods and telling you about them. Also, now that you see how easy it is for BASIC to communicate with machine-language routines through the USR(0) statement, I hope you are encouraged to find additional applications for this versatile instruction.

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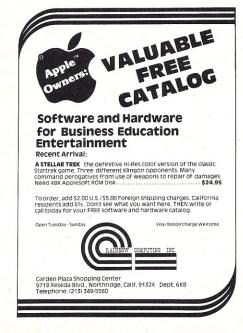
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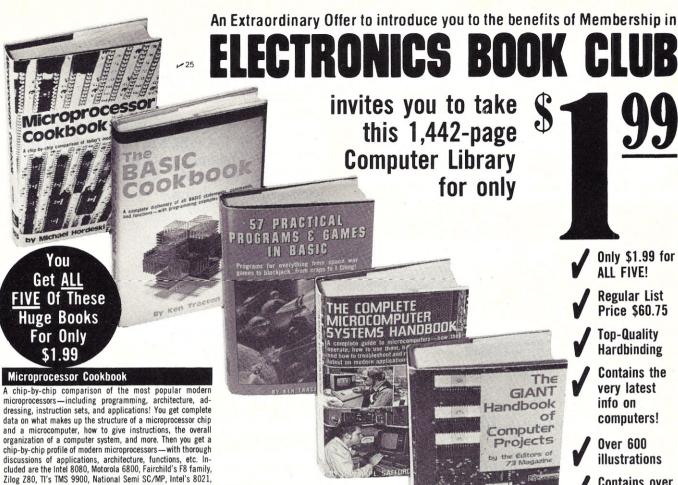
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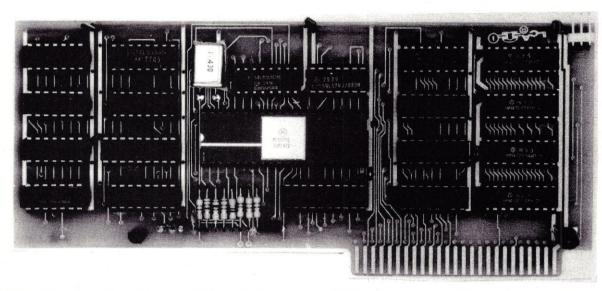
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Heath's H8 Cassette Interface Times Two

Transfer programs to and from a cassette and your H8 at twice the speed.

Ronald Baker 6102 Crockett Dr. Louisville, KY 40258

his article will show how you can transfer programs to and from a cassette recorder to your H8 at twice the speed with a simple modification. In experimenting with my H8 I am constantly transferring data to and from the cassette recorder. One of the things that sold me on the H8 system was the 1200baud rate of their cassette interface. After using the system for a few months even this speed seemed like it took forever to load or dump a program.

In building the cassette interface board I remembered that I had a choice of two speeds: 300

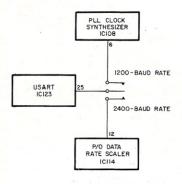


Fig. 1. The switching arrangement between circuits.

or 1200 baud. If I had a choice of two speeds, why not another choice of even a higher speed?

Upon reviewing the schematic, I noticed that Heath uses a nifty circuit with a phase-lock loop that automatically compensates for tape-speed variations. This circuit could be modified for a faster rate, but not too easily. I figured that there had to be a better way. Furthermore, I didn't want to permanently wire the system for a higher baud rate.

All of Heath's program tapes are recorded at a 1200-baud rate, which means I couldn't use it if something new from Heath came along in the future. Since I wanted to operate at a faster rate than 1200 baud, I tried to design a simple modification that would accommodate both Heath's 1200-baud-rate cassettes and my own system to operate at 2400 baud.

Theory

The construction theory is simple. With one exception, the 1200-baud-rate wiring of the board stays the same. The output of the phase-lock-loop clock synthesizer now goes to the USART (universal synchronous/ asynchronous receiver/transmitter) IC123, pin 25, through a single-pole double-throw switch as shown in Fig. 1.

This position on the switch selects the 1200-baud rate. The second position on the switch disconnects IC123 from the clock synthesizer and connects to pin 12 of IC114, the data rate scaler, which is also the 2400-baud-rate clock output.

Thus, when the board is operating at 2400-baud, the clock synthesizer is not used. Instead the clock pulse for the USART comes from the crystal-controlled baud rate generator, IC112 through IC116.

At this point, the disadvantage of disconnecting the clock synthesizer should be obvious. This circuit is what gives you a constant clock frequency with any variation in tape speed. I'll admit that at first I had second thoughts about how well it would perform. There was only one way to find out and that was to try it and see.

The results were quite surprising. I have been using this system at 2400 baud for about six months now without a sign of any problems. It works as well as the 1200-baud rate, but now it's twice as fast.

At this rate of speed your recorder is very important. Battery-operated recorders are

out. Tape-speed variations are too great with the discharge of the batteries. The results will be a checksum error. The recorder I use is a good, inexpensive (\$100 price class) Radio Shack tape deck that runs on 110 V ac. If you use a recorder that has a wow and flutter specification of 0.25 percent or less, it should perform well without any difficul-

Construction Is Easy

The actual construction of the additional circuit takes less than one hour. The only part needed is a single-pole doublethrow subminiature slide switch, which most parts suppliers can provide. Since 99 percent of my operation is at the 2400-baud rate, I mounted the switch directly on the cassette interface board. This makes the switch accessible if I need to switch to the 1200-baud rate, and out of sight for most of my operating. Another advantage of mounting it on the board is that it obviates drilling a hole in the front panel, thus destroying the appearance of the H8.

As shown in the photograph, the switch is mounted in the small vacant area between IC108 and IC113. Note that on the backside of the board this

same area is free of printed circuit. The switch is mounted vertically by drilling three small holes. Size and distance of the holes will vary with the type of switch used.

The end result is that the switch is flush with the board; the switch contacts are on the backside of the board. The switch is held in position on the board with a small drop of epoxy on either side of the switch.

After the switch is mounted, the second step is to cut and remove the foil between the USART IC123, pin 25, and IC108, pin 6. Important: make sure when you cut the foil that the foil connecting IC108, pin 6, to IC107, pin 14, is left connected.

The only thing left now is the wiring.

- 1. Connect a wire from IC123, pin 25, to the middle contact of the switch.
- 2. Connect a wire from the junction of IC108, pin 6, and IC107, pin 14, to the top contact of the switch.
- 3. Connect a wire from the bottom of the switch to IC114. pin 12. This is the clock reference for the 2400-baud rate.
- 4. Connect a wire from the TAPE TX (as marked on the board) to the 2400 position (as marked on the board). The first three wiring steps convert the tape receive circuit. When the switch is up the transfer rate is 1200 baud. The rate is 2400 baud

when the switch is down. The fourth wiring step converts the tape transmit circuit to the 2400-baud.

Operation

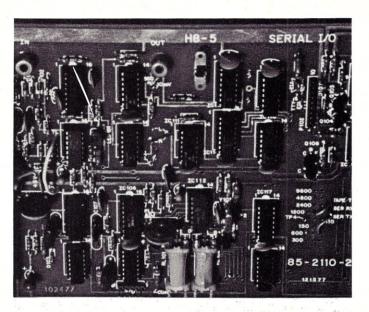
Conversion of your tapes to the 2400-baud rate is simple. Insert a tape previously recorded at 1200 baud into your recorder. Set the switch to the 1200-baud rate. Press the load button on the H8 to load normally. After the program has been loaded, insert a blank cassette into your recorder and press the dump button on the H8 to make a new copy at the 2400-baud rate. Important: use a blank cassette to make a new copy.

Never use the old program tape until a good copy has been made at the new rate. If something went wrong in dumping the program, the original program would be lost. For all programs written in machine language, use the procedure just described.

Use the same procedure to load programs written in BA-SIC; then use the load and dump commands of BASIC in the same manner. After you convert all your program tapes to the new rate, you can leave the switch in the 2400-baudrate position for normal use.

Conclusion

Probably the most important part of the system's operation



The switch is mounted between IC108 and IC113 . . . just below the letters H8-5 printed across the top of the board.

is your tape recorder. Inexpensive battery-operated recorders do not consistently give you reliable service. Use a good-quality tape recorder that operates from 110 V ac.

In selecting a recorder, also keep in mind the frequency response of the unit. When you operate at the 2400-baud rate, the increase in frequency is impor-

For the same reason, use a good-quality recording tape. Keep the recording heads clean, and perform some maintenance on your tape recorder occasionally since this might prevent a lot of trouble later.

The recording level is not critical. It should be about the same at the new rate as at the old rate. If adjustments are necessary, consult the operating manual.

Since the tape transmit circuit is permanently wired to the 2400-baud rate, whenever you dump a program to your recorder it will be recorded at 2400 baud. This means you can load a program at either 1200 or 2400 baud but you can only dump a program at 2400 baud.

This provides a useful, simple and relatively inexpensive method of transferring programs to and from a Heath H8 at twice the normal speed.

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PET Pen

Part 2 of this 3-parter adds a light pen to last month's PET I/O port expander.

William F. Pytlik 9012 Maritime Court Springfield, VA 22153

providing the PET with "eyesight" greatly enhances its capabilities. To take full advantage of the PET's interactive capability, you can add a light pen, which will provide some measure of "eyesight." Darlington-connected phototransistors make implementation of light pens easy. Using the I/O port "Expander" described in last month's article, you can add a simple plug-in printed circuit (PC) card to provide all the circuitry required to interface the light pen with the PET. This article describes the hardware as well as the Shopping List software routine to demonstrate use of the light pen.

Circuit

Fig. 1 shows the schematic of the light pen circuit. The phototransistor, when properly biased and exposed to the light of a blinking cursor, provides an output pulse. This pulse is applied

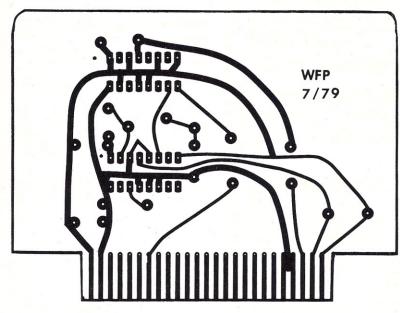


Fig. 2. PC board (full size).

to a one-shot (IC1), which squares and lengthens the pulse. The output of IC1 is then buffered by IC2 and transferred to the I/O port via the I/O port Expander. Position of switch S1 (Device Select 2 on the Expander front panel) determines whether the signal is passed to the I/O port.

If +5 V dc is applied to pin 4 of IC2, the output goes to a high

impedance state—essentially isolating the light pen module from the I/O port. If pin 4 of IC2 is grounded, the pulse is transferred to bit 8 (PA7) of the PET I/O port. At this point, you must use software if you want to

utilize the light pen.

Construction

The plug-in module is constructed using a 3×4 inch PC board, shown in Fig. 2. Although I used photographic PC board

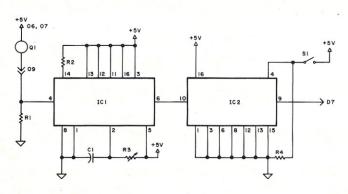


Fig. 1. Light pen circuitry.

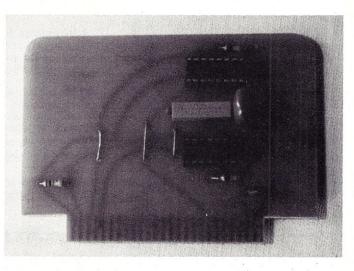


Photo 1. Completed PC board.

construction techniques, you may use either Datak dry transfer etch patterns or a .1 inch grid PC board and a resist pen. All components are mounted and soldered in place using Fig. 1 as a guide. Photo 1 shows the completed PC board.

The light pen consists of an appropriate housing (I used a refillable felt-tip pen barrel), twoconductor wire and a DIN male plug. Fig. 3 presents a sketch of the light pen. Photos 2 and 3 show the components and the complete light pen, respectively.

Software

I've written the Shopping List program to demonstrate just one of the many uses of the light pen. The program, in conjunction with the light pen, provides a method by which you can obtain a printout of a number of items from a long list by simply pointing the light pen toward desired items.

Lines 65 to 150 read the category and a page worth of items. For example, the category might be vegetables and the items lettuce or peas. The data is appropriately formatted and displayed on the screen. At the bottom of the screen, the program prints NEXT PAGE, allowing the user to go to additional data in the list at any time. Subroutine 2000 writes a cursor, which travels from the first item to the bottom of the page. (Note: R3 and screen brightness should be adjusted for best operation; I adjusted R3 to approximately 300k.)



Photo 2. Light pen components.

In addition to writing a cursor, the subroutine also reads the I/O port. If the pen is placed in the path of the cursor next to a desired item, the subroutine will save this item in memory. If the pen is placed next to NEXT PAGE, the program will provide the next page of items. When all items have been displayed, the program goes to the print subroutine at line 1000. (Note: Line 1010 and 1150 are written for my Axiom 801P printer. If you have a different printer, you may have to change these lines. If you do not have a printer, adjust this subroutine so that only 20 of the items are displayed at a time.)

The list of items to choose from is entered starting at line 500. I used only a few items in this sample to conserve space. Note that item END specifies the end of a category, while STOP specifies the end of the list.

My wife regularly uses the light pen to obtain a shopping list in a matter of minutes.

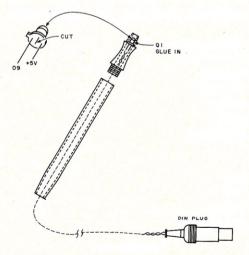


Fig. 3. Light pen construction.

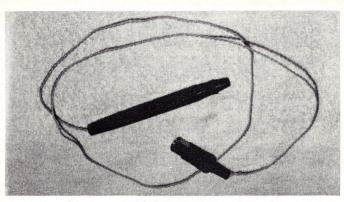


Photo 3. Assembled light pen.

Another application is administration of multiple-choice test questions. If you write the cursor across the entire screen (remember: before writing the

cursor, you must save the affected screen data element and restore it after the cursor is moved), you can use the light pen to draw simple designs.

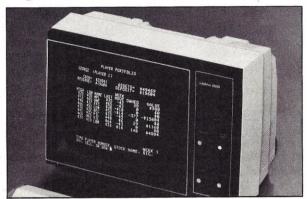
```
IC1
                      CD4528 CMOS dual one-shot
IC2
                      CD4502 CMOS hex buffer
R1
                      10k 1/4 Watt
R2 R4
                      100k 1/4 Watt
R3
                      1 meg trimpot
C1
                      .01 uF (use between 5 V and ground)
C2
01
                      GE L14F-1 Darlington-connected
                      phototransistor
Misc
                      Hardware, wire, IC sockets, etc.
Parts list
                      Parts list.
```

Program listing.

```
10 REM *** SHOPPING LIST ***
 20 REM **OPEN I/O PORT FOR INPUT**
 30 INPUT "LIMMENTER TODAYS DATE";TD$
 40 DIM CA$(20), ITEM$(20,20), OUT$(20,20)
 50 A=1:A1=1
60 X=0:Y=0
65 READ CA$(A)
70 PRINT"WCATAGORY--";CA$(A):PRINT:PRIN
80 REM **DISPLAY ITEMS**
90 FOR I=1 TO 10
100 READ ITEM$(A,I)
105 II=I
110 IF ITEM$(A.I)="END" THEN Y=1:GOTO 1
120 IF ITEM$(A,I)="STOP" THEN X=1:GOTO
150
130 PRINT" | TEM$(A,I):PRINT
140 NEXT T
NEXT
PAGE"
160 REM **GO TO LIGHT PEN ROUTINE**
170 GOSUB 2000
180 IF Y=1 THEN A=A+1:GOTO 60
190 IF X=1 THEN 210
```

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200 GOTO 70 210 REM **GO TO PRINT ROUTINEE** 220 GOSUB 1000 230 END 500 DATA VEGETABLES 510 DATA TOMATO, LETTUCE, BEETS, CARROTS, B EANS, PEAS, CORN, CELERY, CUCUMBER, END 520 DATA MEAT 530 DATA STEAK, HAMBURGER, CHICKEN, STOP 1000 REM *** PRINT ROUTINE *** 1001 PRINT"[" 1010 OPEN 4,4:CMD4:PRINT CHR\$(8) 1015 PRINT "SHOPPING LIST FOR ";TD\$ 1020 FOR I=1 TO A 1030 PRINT 1040 PRINT CA\$(I) 1050 FOR C=1 TO LEN(CA\$(I)) 1060 PRINT""; 1070 NEXT C 1080 PRINT 1090 FOR J=1 TO A1 1100 IF OUT\$(I,J)="END" OR OUT\$(I,J)="5 TOP" THEN 1120 1105 IF OUT\$(I,J)=OUT\$(I,J-1) THEN 1120 1110 PRINT OUT\$(I,J) 1120 NEXT J 1130 NEXT I 1140 PRINT 1150 PRINT#4:CLOSE4 1160 RETURN 2000 REM *** LIGHT PEN ROUTINE *** 2010 PRINT"8" 2020 FOR I=1 TO 11 2030 PRINT" MANUS "": 2040 IF PEEK(59471)<250 AND I>10 THEN R **ETURN** 2050 IF PEEK(59471)(250 AND I(II+1 THEN OUT\$(A,A1)=ITEM\$(A,I):A1=A1+1 60 REM **SLOW CURSOR DOWN** 2070 FOR T=1 TO 1:NEXT T 2080 NEXT I 2090 PRINT" "

SMOPPING LIST FOR 12 AUGUST 1979

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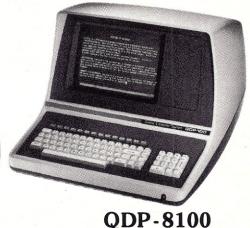
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64K Memory For the Heathkit H8

This single card dynamic RAM plugs directly into the H8.

Myron J. Seibold PO Box 5131 Santa Ana, CA 92704

his article describes a single card, 64K byte, random-access memory designed for the Heathkit H8 computer. The memory is packaged on a 6 inch (15.2 cm) × 12 inch (30.4 cm) board using standard Heath mounting hardware and plugs directly into the H8. The memory bytes are 8 bits in length. The total capacity of the memory, then, is 64K × 8 bits. Of this, only 56K can be used, because Heath reserves the first 8K of memory addresses for other uses. This memory may be addressed from 8K to 64K bytes. It will not respond when addressed in the 0 to 8K bytes range.

This is a general-purpose memory design, which should be adaptable with little modification to almost any small computer. I will show how this memory interfaces with the H8 bus, and, with this example, general memory interfacing requirements will be demonstrated.

A single-card memory is made possible by using the 16K × 1 bit dynamic memory integrated circuit chip. This chip—the 4116—became available over two years ago and is now the industry-standard random-access memory device. It can now be obtained from many manufacturers at reasonable prices and should soon be finding its way

into many home computer designs.

Memory Chips

Semiconductor memories began to compete successfully with magnetic core memories with the introduction of the 4K×1 bit metal oxide semiconductor (MOS) memory chip. 4K memory chips became available about 5 years ago and were introduced in a wide variety of styles—16-, 18- and 22-pin parts. Some used static storage techniques, while others used dynamic techniques. There was little compatibility between manufacturers of similar parts.

Static memory chips store information in a flip-flop circuit, usually consisting of six transistor elements. Stored information is nonvolatile as long as power is applied. Static memory chips require little additional support circuitry and are easy to use. Memory expertise is generally not required to design with static memory chips.

Dynamic memory chips store information as a charge on a capacitor. This capacitor is usually connected to the other memory circuits on the chip with a single transistor switch. A separate capacitor and switch are required for each bit of information stored on the chip. The charge stored on the capacitor gradually leaks away and must be periodically restored. This operation is called refresh. Dy-

namic memory chips require considerable additional support circuitry. Good printed circuit board layout practices are essential.

Dynamic memory chips have many advantages over static chips. They are less expensive per bit of stored information, store more information per chip and use less power. They provide significant savings in computer chassis space.

One 4K dynamic memory chip (type 4096) was introduced in a 16-pin package that had six address inputs. The 12 memory address bits required to address 4K were multiplexed into the memory chip in two steps, using these six inputs. This was considered a very radical technique, and it was predicted that this chip could not compete with more conventional 4K memory chips.

Not only was this chip very successful, it provided the technique required to build the next generation memory device: the 16K×1 bit dynamic memory chip. All 16K memory chips are alike, and chips from all manufacturers may be used interchangeably. This is also a 16-pin part, with seven multiplexed address inputs. Static 16K memory chips are not available.

At this time, 64K × 1 bit dynamic memory chips (type 4164) have been announced. These parts also use 16 pins and have eight multiplexed address in-

puts. These new 64K chips use a single power supply voltage, +5 volts. The older 4K and 16K chips use three power supply voltages: -5 volts, +5 volts and +12 volts.

Using the 16K Dynamic Memory Chip

The 4116, 16K × 1 bit memory chip package has 16 pins, as previously noted. Seven of these pins are address inputs, three are power supply inputs, one is for data input, one is for data output and one is ground. There are also three timing strobes: RAS (Row Address Select), CAS (Column Address Select) and WRT (Write). All inputs and outputs (address, data and timing strobes) are TTL compatible. They may be connected to standard TTL integrated circuit inputs and outputs.

The three timing strobes are normally held at a high level and are asserted when driven to a low level. The memory cycle starts when RAS is asserted. The seven address inputs must be applied before this time. These addresses are latched into the memory chip when RAS is asserted. A short time after RAS is asserted, seven new addresses are applied to the memory chip address inputs. (A total of 14 address bits are required to address 16K of memory.) CAS is then asserted, latching these additional seven address bits into the memory chip. WRT should

Memory Access chip time 4116-2 150 NS 4116-3 200 NS 250 NS 4116-4

Table 1. Memory chip access times.

remain high for a memory read cycle. Valid memory data will appear at the memory chip data output after a certain time following the assertion of RAS.

This time (memory chip access time) is specified according to the grade of memory chip used. Three grades are available; their respective access times are given in Table 1. The fastest chip, the 4116-2, is the most expensive. All three grades are made using the same process and are screened into these categories by testing. Memory data will remain valid at the memory chip output terminal until the end of the memory cycle, when RAS and CAS are released.

WRT is asserted for a memory write cycle. Input data is latched into the memory chip upon the assertion of either CAS or WRT, whichever is asserted later. If the input data is changed after this time, it will not be stored in the memory chip.

I included this information concerning the 4116 memory chip to aid in understanding the operation of the memory. It is not sufficient for design purposes or to make design changes. Further information may be obtained from the manufacturer's data specification sheet for this part.

Refreshing the Memory Chips

The entire memory must be refreshed once every two milliseconds. A memory refresh cycle differs from a normal memory cycle in that only RAS is asserted. The memory must be refreshed for all row addresses. There are seven row address inputs; therefore, the memory must be refreshed 128 times. every two milliseconds. The refresh cycles are normally evenly spaced 16 microseconds apart. This will provide 128 refresh cy-

cles in 2 milliseconds. A refresh cycle typically has a duration of one-half microsecond. The memory will, therefore, be performing refresh cycles less than 5 percent of the time.

Memory refresh cycles potentially interfere with computer memory cycles. Refresh cycles must be synchronized with the computer to prevent interference. The operating cycles of most computers can be extended by the assertion of a "stall" signal to accommodate memories with excessive access times. Use can be made of this provision when the memory is performing a refresh cycle.

The start of a computer memory cycle will be delayed until completion of the refresh cycle, and the computer stall signal, meanwhile, will be asserted until the memory can accept or provide computer data. The Heathkit H8 bus has a signal line called RDYIN on connector pin 20, which may be used to extend the operating cycle of the computer.

Frequently, memory refresh cycles can be timed so that the computer does not have to wait for the completion of a memory refresh cycle. In this case, the computer stall signal need not be asserted. Refresh is then said to be transparent. The stall signal may be used once on start-up and occasionally when the computer is using the memory at a low repetition rate. The stall signal will not be asserted when the computer is using the memory continuously.

This memory design features transparent refresh. There is sufficient time between computer memory cycles to follow a computer memory cycle with a memory refresh cycle. Refresh cycles will be generated in this case only when required. The memory should not be refreshed excessively, as the power requirements for refresh are significant.

Interfacing the Memory to the Computer Bus

The Heathkit H8 bus operates the memory with a minimum of signal lines. There are 16 address lines to address up to 64K bytes of memory. There are eight bidirectional data lines, which can either supply data to the memory or receive data from the memory in 8-bit bytes. There is a memory read input and a memory write input. Provision for a memory output to stall the computer (RDYIN) is also available on the bus. There are three power supply voltages, as well as two ground connections. A total of 32 connections is made to the memory from the computer bus.

The H8 memory cycle has a duration of 1500 nanoseconds (see the memory timing relationships shown in Fig. 1). The memory read command pulse width is 750 nanoseconds; the memory write command pulse width is 1150 nanoseconds. A memory cycle will be either a read cycle or a write cycle, depending upon which memory command is used. A memory cycle nominally begins when a memory address

is applied to the address lines. This occurs 200 nanoseconds prior to the assertion of either a read or a write command. Both the read and write commands are positive pulses on the bus.

Memory data is expected on the bus 300 nanoseconds after the assertion of a memory read command. Similarly, data to be written into the memory is available on the bus 300 nanoseconds after the assertion of a memory write command. Address and data information remain valid on the bus until the release of the memory read or write commands.

The memory access time requirement, measured from the assertion of the memory addresses on the bus, is 500 nanoseconds. The 8K static memory used by Heath (H8-1) has a specified access time of 450 nanoseconds. However, the static memory cycle starts when the memory addresses are asserted. The dynamic memory cannot start at this time and must wait until a memory read or write command is applied. Accordingly, 200 nanoseconds are lost from the memory access time. This is the primary reason for using the faster "dash 3" (4116-3) memory chips. With these, the memory module access time measures 500 nanoseconds and can be set faster if required.

Memory read data is applied to the bus through a latching bus driver. This driver has a highimpedance output, unless it is applying data to the bus. Read data remains latched on the bus

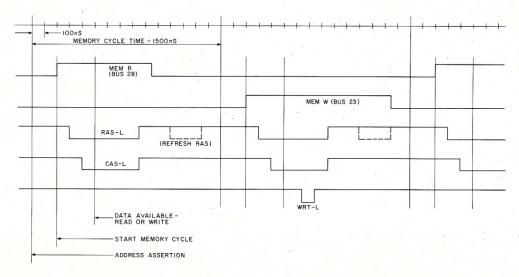


Fig. 1. Memory timing relationships.

until the release of the memory read command. The memory itself is free for refreshing immediately after data is latched on the bus.

Data to be written into the memory may not be available until 300 nanoseconds after the assertion of the memory write command. Data must be latched into the memory chips, using the WRT command, after this time.

As previously stated, the memory cycles are started by the assertion of the memory read or write commands. The duration of these commands has no affect on memory operation. The memory cycle finishes as soon as possible, followed by a short pause. The memory is then ready to begin a refresh cycle. There is time for a refresh cycle and another pause before the next memory cycle will be requested. Synchronized in this way, memory refresh cycles do not delay execution of the computer memory cycles.

The extended duration (1150 nanoseconds) of the write cycle command is a potential problem. This enables the computer to write late data into a static memory. The dynamic memory can be easily modified to write late data, but at the expense of transparent refresh. Since no problem exists at present, I decided not to worry about late data entry. A problem could conceivably exist in the future with certain types of interfaces or system configurations. In this case, the memory cycle time must be extended and application of WRT delayed accordingly. The provision for transparent refresh must then be disabled.

To adapt this memory to a computer other than the Heath-kit H8, the computer bus requirements will have to be determined and appropriate changes made in the memory interface circuits and possibly in some of the timing circuits. The best way

to examine the computer bus signals is to probe the bus terminals using an oscilloscope while running the computer using a short program loop entered in machine code.

The use of these test loops is invaluable, as known operating conditions can be established on the bus. These loops should be made as short as possible. Different loops can be used to provide different bus conditions, for example, (1) store accumulator in memory (write into memory) and return or (2) load accumulator from memory (read from memory) and return. Front-panel monitor routines should be disabled when running these loops, if possible. The bus signals can be spread out in intelligible patterns by synchronizing the oscilloscope on an appropriate higher-order address bit. This synchronizing address change can be written into the beginning of the test routine.

The Heath H8 bus operation

is conventional, and little modification should be required to adapt this memory for use with another computer. As noted, it will probably be necessary to change a few of the input circuits to convert this memory to another computer bus. The memory timing is essentially independent of the computer, and little modification of the timing should be required in this case. I modeled this memory after one of my best commercial designs, which I readily adapted to the H8 bus.

If another computer does not provide sufficient time between memory cycles for transparent refreshing, this circuit in the memory should be disabled by connecting U56-3 (see Fig. 2) to a +5 volt bias resistor (or to ground) instead of to U69-12. When this is done, all refreshing will be asynchronous and the computer stall signal will be used to prevent interference. The increase in computer oper-

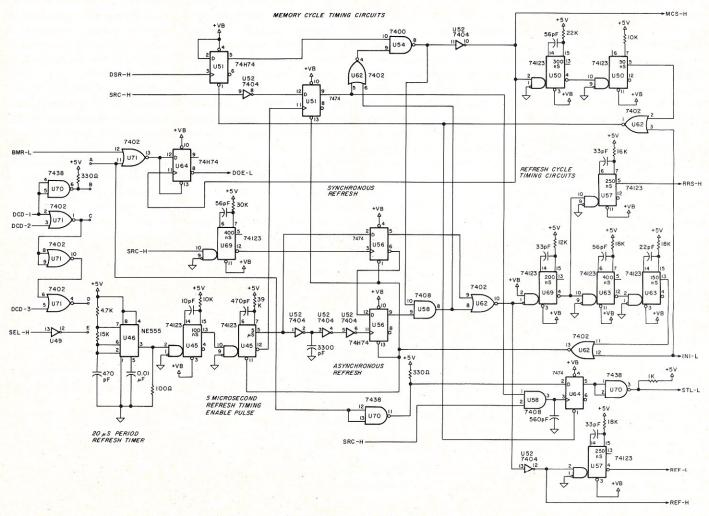


Fig. 2. Memory timing circuits and refresh synchronization.

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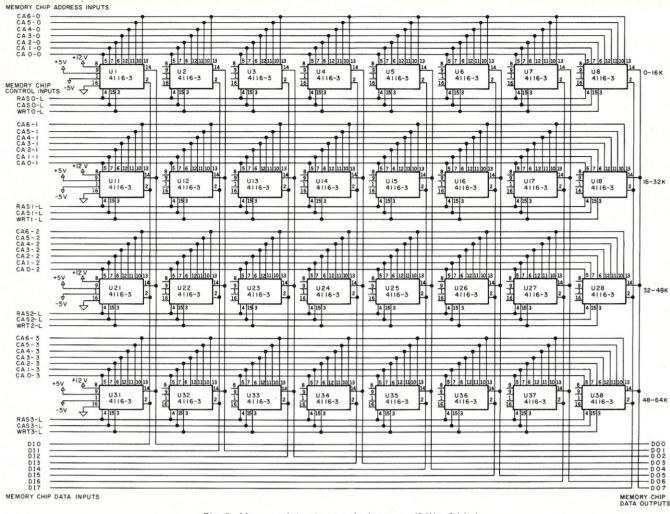


Fig. 3. Memory data storage device array (64K \times 8 bits).

ating time required for asynchronous refresh usually will not be noticeable.

Address Range Selection

You can build this memory in a smaller size version having less memory capacity by simply omitting one or more rows of memory chips. These chips can later be added, one row at a time, to increase memory capacity. A smaller version of this memory is fully compatible with any existing memory now being used in the H8 computer. This new memory always runs at the lower memory addresses. Exist-

ing H8 memory must be rejumpered to run above this memory.

There are four address selection jumpers on this memory. They select one of the following address ranges: 8K to 24K, 8K to 40K, 8K to 56K and 8K to 64K. These address ranges correspond to memory sizes of 16K, 32K, 48K and 56K, respectively. The address selection jumper must be installed for the appropriate case. See Table 2 for address selection jumper installation. Additional memories used in the H8 computer must be iumpered continuously above the range selected for this particular memory.

I incorporated this provision for address selection after the memory was designed and built. There is no need for this feature with a full 64K memory. Integrated circuit number 71 is not shown on the memory module layout drawing (Fig. 3). It will have to be squeezed in somewhere. Perhaps it will fit between U68 and U69. Use of a 16K memory chip (4116) results in a 16K minimum increase in memory capacity. The address range increments in 16K steps (from a minimum 16K capacity), accordingly.

Memory Module Circuit Description

The memory continuously generates refresh cycles whether the computer is using the memory or not. Much of the memory circuitry can be checked and the timing adjusted simply by working with the refresh signals. This is important because

some initial adjustment may be required before the computer will work with the memory.

Refresh cycles are timed by oscillator U46 (see Fig. 2), whose period is approximately 16 microseconds. A 100 nanosecond pulse is generated every 16 microseconds by applying the output of this timer to one-shot U45. A 5 microsecond refresh enable timing slot is generated when the 100 nanosecond pulse is applied to the other half of U45.

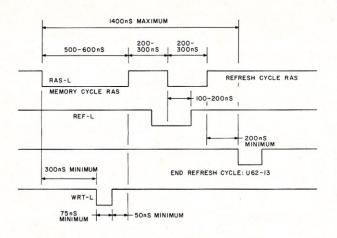
If a memory cycle occurs during the 5 microsecond refresh enable interval, a refresh cycle will be initiated immediately following the memory cycle. In this case, the output at U56-5 will start the refresh cycle. If there is no memory cycle, the termination of the 5 microsecond timing interval will initiate the refresh cycle. In this case, the output at U56-9 will start the refresh cycle.

In either case, the refresh cycle will start when U62-10 is asserted. A delay set by U69-4 will

Install Jumper Wire Memory Address Selection Range

A to B 8K to 24K
A to C 8K to 40K
A to D 8K to 56K
A to E 8K to 64K
Install a Single Jumper Wire as Indicated Above

Table 2. Jumper wiring for memory address range selection.



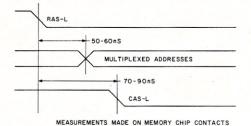


Fig. 4. Detailed timing specification.

occur before the application of refresh RAS to the memory chips. A delay is required between successive applications of RAS to the memory chips, between the memory and refresh cycles. During this delay, the address multiplexer applies the outputs of the refresh counter to the memory chip address inputs. The refresh counter is advanced with each refresh cycle. When refresh RAS is removed from the memory chips, there is another delay, after which the refresh cycle is terminated. The memory is now ready to begin a computer memory cycle.

A computer memory cycle is initiated when the input at U51-3 goes high. This will cause the output at U51-5 to go high, provided a valid memory address has been received. If the address is in the range 0 to 8K, the input at U51-2 will be low and the output at U51-5 will not change. If a refresh cycle is in progress. the input at U54-9 will be low and a memory cycle will not begin until U54-9 goes high at the end of the refresh cycle. A memory cycle begins when U54-8 goes low. The duration of the memory cycle is determined by one-shot U50-4.

All timing information given on the schematic is for reference purposes only to aid in following the operation of the schematic circuits. The memory should be timed according to the detailed timing specifications shown in Fig. 4. The value of an occasional one-shot timing resistor may have to be changed to obtain this timing. Timing not shown in Fig. 4 is not critical and should be obtained using the component values given on the schematic.

Seven address inputs are simultaneously applied to each row of memory chips. These addresses come from the address multiplexing circuits (see Fig. 5). Fourteen address inputs (A0 through A13) from the computer are separately applied to the memory chips in two steps, using the address multiplexing circuits, to select a memory chip address. In addition, seven refresh addresses are generated by the refresh counter, which advances by one count with each refresh cycle. The refresh address counter repeats after every 128 refresh cycles.

The memory address decoder

(U44) decodes the memory addresses in 8K blocks throughout the address range (see Fig. 6). 64K is decoded using eight decoder outputs. Address bits are asserted on the bus when they are brought low. All address bits will be high for the lowest address count (000 000). All address bits will be low on the bus for the highest address count (377 377). 8K decoding blocks are necessary to disable the memory when addresses are selected in the lowest 8K range. The SEL-H line connects to U44-7 to accomplish this.

The decoder outputs are then paired using U43 to provide a 1-out-of-4 decoded address (four 16K decoding blocks) to select one of the four rows of 16K memory chips. The memory RAS timing signal, MCS-H, is applied to only one row of memory chips at a time. This is the addressselected memory chip row. Conversely, the refresh RAS timing signal, RRS-H, is applied to all memory chips simultaneously.

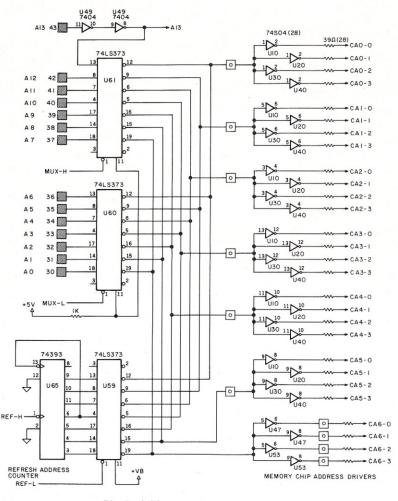


Fig. 5. Address multiplexing circuits.

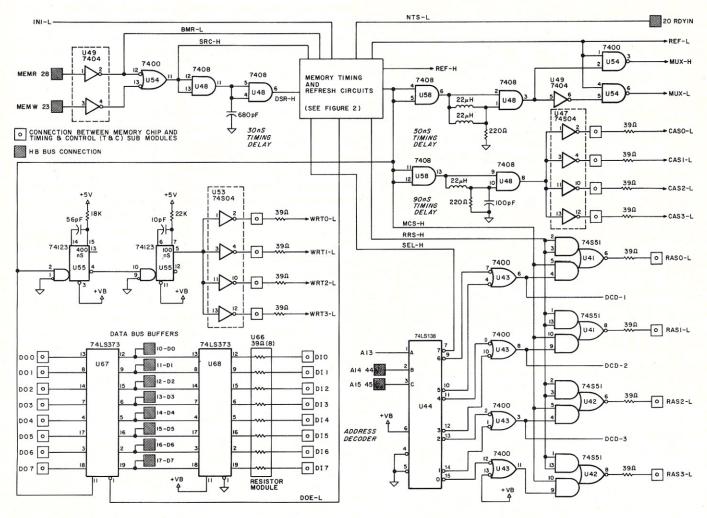


Fig. 6. Memory control circuits.

CAS and WRT are also applied to all memory chips simultaneously during computer memory cycles. Only RAS is applied to the memory chips during a memory refresh cycle.

The memory chips are laid out in an array of four rows, with eight chips in each row (see Fig. 3). Respective address and control inputs are connected together in each row, which has separate address and control drivers in order to reduce the load on each driver. The dc input resistance to the memory chips is very high, whether they are driven high or low. However, the inputs have significant capacitance, which requires good drivers and series damping resistors.

The MOS memory chip inputs are TTL compatible; however,

they are not the same as TTL inputs.

All the respective memory chip power supply voltages are connected together. This is not shown on the schematic, but it is understood. The memory chip data inputs and outputs are connected together by column, rather than by row. There are eight columns of data input and output lines, with four memory

chips in each column. The data lines are thus connected to the memory chips in opposition to the address and control lines. In this manner, the memory chip array is formed.

This concludes the actual design of the memory for the Heathkit H8 computer. Next month, in part 2, we will consider the construction, operation and trouble-shooting of the memory board.

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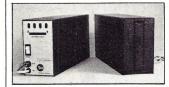
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A Use for Misprogrammed PROMs

Don't throw away those misprogrammed 8223s!

George Young Box 11 Auberry, CA 93602

was recently looking for a decoder with six inputs to use to provide Chip Enables (CEs) for random access memory (RAM). The 75154 met the necessary requirements, but the 74154 comes in a 24-pin package, and I did not have enough "real estate" available to add a 24-pin package to the board.

The 7488/8223 had the necessary six input pins—five address lines plus the $\overline{\text{CE}}$ pin. It has 32 outputs, but only eight are mutually independent. It would provide only half the number of outputs of the 74154, but I did not need 16 outputs; eight were adequate.

As a high school teacher of electronics, I had quite a few misprogrammed PROMs "in stock." Students make errors programming them, and a single error ruins an 8223. However, don't throw away misprogrammed PROMs.

What to Do

The PROM matrix is depicted in Fig. 1. All we need is a group of lows still remaining in one of the four sections of the PROM. These do not even have to be sequential as indicated by the

slanting squares in Fig. 1. We do need at least one different low remaining on each of eight consecutive rows of the matrix.

With pins 12, 13 and 14 all low, we will access the eight rows at the top of the matrix. Pin 12 high, pins 13 and 14 low will allow us to use the second group of eight rows. With pin 14 high, we are in the bottom half of the matrix. With pin 13 low, we access the third group of eight rows, while with pin 13 high, we access the fourth group of eight rows.

Once the group of eight mutual lows are found in the matrix, the rest of the cells are all burned high, pull-ups are added, and the address lines are used with, or without, inverters to access the one-quarter of the chip that will be used as a decoder with eight outputs. The pull-ups can even be omitted, and the decoder will still function.

The chip enables are active lows. If you require active highs, the eight outputs can be inverted with 7404 sections. You could program an 8223 for the eight active high CEs, but this would *not* be using a misprogrammed 8223.

At first glance, the usual response is, "What a waste!" But remember, we are using misprogrammed PROMs here that normally find their way into the "round file."

Two PROMs will provide $\overline{\text{CEs}}$ for 16K of address space in 1K increments, requiring less real

estate and less power than a single 74154 (but not less power than a 74LS154).

Now don't you wish that you had saved all those misprogrammed 8223s?■

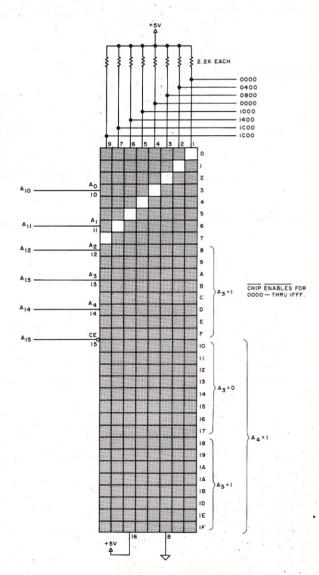


Fig. 1. 7488/8223 PROM matrix.

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Thoughts on the SWTP Computer System

Like this series, 6809 systems are proliferating.

Peter A. Stark PO Box 209 Mt. Kisco, NY 10549

The first SWTP 6809 system was the MP-09, which used the old 6800-style cabinet and a slightly modified MP-B2 mother-board. It is the latest 6800 motherboard, but is modified to place I/O at address E000 instead of 8000

The S/09 system features a new cabinet, new motherboard. beefed-up power supply and even a fan. In this motherboard, all the cards-50 pin, as well as 30 pin-are parallel with the sides of the cabinet. The motherboard also has some new circuitry, including an interrupt timer, extended address decoding and a baud rate generator. The baud rate generator on the motherboard releases the baud rate lines on the 50-pin bus and lets them be used as address lines, so that the S/09 system comes with a standard 20-bit address bus.

Now the MP-09 system has been changed. It occupies the same cabinet as the S/09 but has an MP-B3 motherboard, which looks like the old motherboard, with the 50-pin cards parallel with the front of the cabinet and the 30-pin cards parallel with the sides. The larger cabinet allows the use of the new

30

older system could use—with some changes—a 6800 CPU card and could run with the old SWTP mini-floppy controller and older I/O cards. On the other hand, the new motherboard will not work with a 6800 CPU card, nor will it work with the old minifloppy disk controller (model DC-2). SWTP has now rede-

lect one of those four addresses. The new motherboard assigns 16 addresses to each port and supplies four address lines to each I/O board. This changes the board-addressing requirements so that some old boards will no longer work.

SWTP has, therefore, designed new I/O boards and eliminated the wiring tangle from the boards to I/O devices by placing the I/O connector on the rear edge of each card, so it is right up against the rear panel. They have also made other changes. They have replaced the MP-S serial interface with a \$100 serial interface that has two ports instead of one. Also, EIA RS-232C has replaced the current-loop interface.

The new system has one other drawback: SWTP is no longer supplying schematics with their equipment, even to dealers. They prefer to have equipment shipped back to them for service. I wonder what the reaction to this will be in Europe, where the 6800 seems to be much more popular than the 8080.

The S/09 system fea-

tures a new cabinet, new motherboard, beefed-up power sup-

ply and even a fan.

DMAF2 disk controller card, which was too large to fit into the older cabinet. It's also much sturdier than old SWTP cabinets, with 1/8 inch aluminum and hefty side rails.

But there is a big difference between these new MP-09 systems and the old MP-09s. The signed the controller, and the new DC-3 is just now becoming available.

It is essentially a problem of address compatibility. SWTP 6800 systems assigned each I/O port four addresses and supplied two address lines to each port to allow the I/O card to se-

6809 and 68000 Rumors

I teach computer technology

at a New York City junior college; our program concentrates on the 6800 because of its simplicity, as compared with some other processors. Among all our systems, we have eight SWTP systems and almost two dozen Heath 6800-based trainers. We plan on purchasing one 6809 CPU board to stay current but have tentatively decided to leapfrog over the 6809 and go directly to the 68000 in another year or so.

Richard Don of Gimix indicates that his company is already looking forward to the Motorola 68000 chip, which will use 16-bit data and include features rivaling today's minicomputer. The question is, "What systems will use it?"

Since there are so many SS-50 systems, many of the SS-50 suppliers are interested in offering a 68000 system that will be compatible with existing hardware. This is no minor matter, since all existing buses use 8-bit data, whereas the 68000 will use 16-bit data.

Alpha Micro, with its 16-bit processor and the S-100 bus, is multiplexing the sixteen data bits over the existing 8-bit data bus. This allows existing memory and other boards to be used with the new CPU, though it slightly slows down operation. A similar idea could be applied to the SS-50 bus and the 68000.

My suggestion is to design a new SS-50 motherboard with the 68000 CPU board occupying two slots in the center of the board, and eight of the data bits going to one end of the motherboard, while the other eight go to the other end. In this way, the 16-bit memory data could be stored in parallel in two 8-bit memory boards.

Whichever way it goes, though, one message is clear: Many manufacturers presently involved in making SS-50 bus equipment want to keep the 68000 compatible. And that should be welcome news to those of us with a heavy investment in 6800 hardware.

Memory Expansion

Since last month's report on expanding the SWTP 32K memory board, two friends have used the instructions to expand their boards from 16K to 32K, and everything has worked out well. In each case, they used a "16K memory add-on for the TRS-80" kit (\$80) to add the extra 16K. You must make sure that you use fast chips (i.e., 250 nanosecond ICs) to make sure everything works well; otherwise, you may get errors.

Gimix also has a 32K board that is fully static. Using 2114 low-power chips, it takes only about 1.8 Amps, and it's reasonably priced at \$548.15. It will work at 2 MHz; the SWTP 32K dynamic board will not. (Since the SWTP 16K/32K board does all refreshing during phase 1 of the clock, actual reads and writes are limited to using only the phase 2 portion of each cycle. At a CPU speed of 1 MHz, this leaves less than 500 nanoseconds for an entire read/write cycle; this is tight, but quite workable as long as the memory chips are fairly fast. At 2 MHz, the time available would be less than 250 ns, requiring memory chips with access time of perhaps 100 ns, or even less.) This is important to users of the Smoke Signal Broadcasting 8 inch floppy-disk system, which requires computer operation at the 2 MHz speed.

ROM Notes

If you want to use a 2716, but only need 1K of EPROM, consider the 2758. It's a "defective" 2716, with just 1K of usable memory. Sound familiar? It can be programmed with the SWTP 2716 programmer and used in the MP-A2 CPU board. Some suppliers sell it for a higher price than a real 2716. But that may change.

Pin 19 of a 2716 is normally the most significant address bit, A10. On the 2758 it is renamed AR and called a "voltage reference." For the standard Intel 2758, this pin should be held at ground, but there is an alternate version, 2758-S1865, which requires +5 volts on AR. When you think of it as an address pin, you realize that the standard 2758 has a good lower 1K, always requiring A10 at 0, while the 2758-S1865 has a good upper half that requires A10 at 1.

More Memory Expansion

Later on, I'll describe a need for some scratchpad RAM, out of the way of other programs. The ROM monitor, of course, already has a scratchpad RAM in the form of a 6810 on the CPU board, but often you need an even larger scratchpad. How can we get such an enlarged scratchpad memory at the least cost?

Although there is a 6810 RAM

USER switch closed, it will be at C000. Just remember never to close both switches simultaneously.

With this modification, this 128-byte scratchpad RAM will occupy the region from C000 through DFFF, reappearing in this 8K address space 64 times. That is, location C000 is the same as C080, C100, C180, C200 . . all the way up to DF80. This wastes space because the RAM address is in-

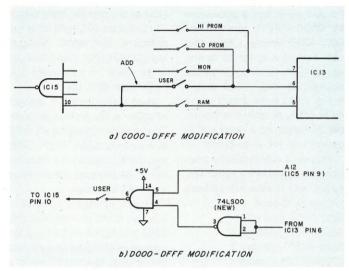


Fig. 1. Moving CPU scratchpad RAM.

memory on SWTP CPU boards, many systems have the 6810 disconnected to leave room for a 4K or 8K memory board located at \$A000 for use with a disk operating system, such as Flex 2.0 or Percom's MINIDOS-PLUSX

You can reconnect the 6810 on an MP-A2 CPU board with two wires in about five minutes, but readdress it elsewhere. You can use this 128-byte memory area—safely away from other memory where it might be clobbered by BASIC or other programs—for your own monitor or other routines.

The simplest way is to move it to lie at C000 (though this is only usable if addresses C000-DFFF are unused). It will then occupy C000-DFFF (just as it used to take up A000-BFFF). The modification uses the USER position of the DIP switch located on the CPU board. Just wire the USER switch as shown in Fig. 1a. With the RAM switch closed, the RAM will be at A000; with the

completely decoded; this is the same case with the normal CPU scratchpad RAM at A000-A07F.

The monitor program I'll discuss later uses additional RAM at D000. This memory at C000–DFFF is just the thing for that, since the decoding makes it also appear at D000. If address C000 is already occupied, then the modification changes (Fig. 1b). This time, the RAM is selected only if bit A12 is 1, which occurs for addresses starting with D, but not C.

It is also possible to expand the existing 128-byte RAM by substituting other memory ICs instead of the 6810. A small addon board that allows two 2114 RAMs to be plugged into the 6810 socket to provide 1K of memory at A000 (C000 or D000 with the above modification) is available from Bruce Naples, PO Box 192, Oakland Gardens, NY 11364. A complete kit, including board, ICs and connectors, costs \$30, postpaid.

You can also use a 4K board

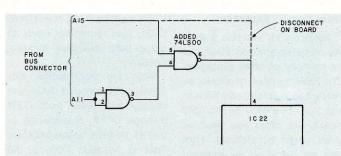


Fig. 2. 2K modifications to 4K board (74LS00 pin 14 to +5 V, pin 7 to ground).

as a 2K board. This may sound strange, but it's useful. I have a Percom video board addressed at D800-DFFF, which left D000-D7FF empty. I filled this with half of a spare 4K board, which was usable as an added scratchpad. The circuit shown in Fig. 2 has to be added to the 4K board to disable it in the upper 2K range, so it does not interfere with the video board.

This mod automatically positions the board in the upper 32K, so just wire the board's address jumper as follows:

9000-97FF—jumper 1 A000-A7FF—jumper 2 B000-B7FF—jumper 3

C000-C7FF—jumper 4 D000-D7FF—jumper 5

If you have a video board, avoid the temptation to use an unused part of its RAM as a scratchpad RAM. In general, whenever the CPU is accessing video board RAM, this same RAM is not available to the video circuits, and so the screen has a small blotch due to a missing character. Normally, this happens only when new video data is being fed to the board, but if you use part of the RAM as a general-purpose scratchpad RAM, then you may get a lot of interference with the display.

Percom LFD-400 Modifications

A few months ago (February 1980), I suggested that you use your 2708 programmer to modify Percom's LFD-400 disk operating system EPROMs. I have since then modified mine even more.

One modification increases the size of the disk directory from two to four sectors, which provides for up to 63 files, rather than the standard 31 files. This requires changing the MINIDOS-PLUSX EPROM (A2 to A4 in locations C4FC, C520, C567, C69A, C6BE, C702, C77C and C78B).

At the same time, I moved the start of the first file from sector 010 to sector 004, right after the directory. This again changes MINIDOS-PLUSX (C6C3 from 01 to 08, C6C6 from B9 to BA and C6DF from 06 to 00).

Next I substituted > instead of @ for a file protection code. This required changing 40 to 3E in locations C563, C59F, C735 and C769. I needed this because my CT-64 terminal doesn't have @ on the keyboard.

Finally, changing 22 to 27 in location C17C of MINIDOS and C608 of MINIDOS-PLUSX opened up the full 40 tracks of my drives to the DOS. The last sector of a disk is now 399 rather than 349. Most Percom software, except the Percom Assembler, which doesn't go past sector 349, relies on the DOS for sector checking and so works well with 40 tracks.

These changes gave me 396 usable disk sectors instead of 340, an increase of 16½ percent from 87,040 bytes to 101,376 bytes.

When I first received my Percom LFD-400, I was using a 2716 EPROM in the C000-DFFF area, so it was inconvenient to use C000 and up for the disk. I therefore made a slight modification on the disk controller board, which moved the whole board from C000 to 9000. This involved cutting the traces that bring A14 and A12 to B10 and B11 on the controller and interchanging the address bits so that the address decoding changed from

A15 A14 A13 A12 1 1 0 0 = C to A15 A14 A13 A12 1 0 0 1 = 9 This moved the 2708 EPROM on board the disk controller to 9000 and up and moved the actual disk control addresses from CC00 down to 9C00.

At this point, I was faced with modifying all Percom software that used DOS routines to the new addresses, which seemed a formidable task. Instead, I burned both MINIDOS and MINI-DOS-PLUSX into a single 2716 and left it at C000, but on the CPU board. (Needless to say, this required changing all disk addresses within the monitor from the CC range to 9C.) Everything was now compatible with Percom software, none of which accesses the disk controller directly, but left another 6K open above C800 for more EPROM.

I have recently returned back to the original addresses (since I now have a 2708 EPROM board at E000 and RAM at 9000), but this same modification may be still useful to others.

Percom has released a software item that allows the LFD-400 drive to run either mini-Flex or Flex 2.0. This program reads any Flex soft-sectored diskette on one Percom drive and copies it onto a ten-sector hard-sectored diskette on the other drive; then it substitutes different disk drivers into Flex. Flex then runs exactly the same as if it was on an SWTP disk system, with the only difference being that it uses hard-sector diskettes instead of soft-sector diskettes. Thus, your disks won't be usable on someone else's SWTP disk system, although you can translate regular Flex disks into the Percom format and use them.

Having used the system, I'm impressed. It runs faster than Flex on an SWTP disk and is otherwise exactly the same. In fact, some of the Percom software can still be used—you have a choice of using either the Flex Backup or the Percom Backup routine to copy Flex disks. Percom's is much faster!

There is also a version for running Smoke Signal Broadcasting's DOS on a Percom system.

Another Percom product is an improved data separator that plugs into the SWTP disk controller to improve the read error rate. Though designed mainly for the TRS-80, it also speeds up

the SWTP disk system. The reason is that when the verify option is used, each write to a disk is followed by a read to check that writing was done correctly. This slows down disk operation, especially when read errors occur, since the DOS will reread the sector several times when an error is detected. Reducing read errors by adding this Percom data separator should, therefore, speed up not only reading, but also writing. I was told that the difference is very obvious.

Tape Read Errors

Occasionally, someone sends me a Kansas City tape that I absolutely can't read. This is usually due to distortion or bad head alignment in making the tape. I have recently found a solution which helps most of the time.

In the August 1978 issue of Kilobaud Microcomputing ("Copying Computer Cassettes," p. 94), I described a device for copying Kansas City tapes. This data regenerator takes a tape signal and cleans it up so it can be rerecorded. Inserting this circuit between my cassette player and the input to my cassette interface has helped me read many tapes that I could not otherwise decipher (printed-circuit boards for the circuit are no longer available).

Monitoring Cassette Loading

When you load a machine-language cassette program using the monitor's L command, the monitor turns off the echo function so that you cannot see what you are reading on your terminal. At the same time, it turns on the reader control line to switch the cassette interface from keyboard to tape input.

If you don't need the reader control signal, then it is easy to enable the echo. In SWTBUG, instead of typing in the L command, simply jump to LOAD3 in the monitor by typing J E00F. This will bypass the part that turns off echo. Another way to do this automatically is to put a segment that loads a 00 into location A00C (SWTBUG's PORECH location) at the beginning of the tape being loaded.



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Computronics 50 N. Pascack Rd. Spring Valley, NY 10977 914-425-1535

Apple trademark, Apple Corp., TRS-80 is a product of Radio Shack, a division of Tandy Corp., Sorcerer trademark is a product of Exidy Corp., and Pet trademark is a product of Commodore Corp.

Unfortunately, there is no easy way to do this when using the O L command.

CPU Clock Speed

The CPU clock in the older MP-A CPU board is crystal controlled at just under 900 kHz. The clock frequency in the newer MP-A2 board is, however, controlled by an RC network, which has a tendency to drift all over the place. Most of the time it doesn't make much difference, but there are some cases (such as when using the JPC 4800 baud cassette interface or some disk systems) where clock speed is important.

It is easy to make the MP-A2 crystal-controlled. Simply remove C1, the timing capacitor connected to the 6875 clock IC

speed is exactly 1 MHz. Simply run the program, time how long it takes and compute your clock frequency from the following formula:

100 clock freq. (MHz) = _

time (sec)

For example, with a 3.579 MHz crystal controlling the clock rate, running time for this program is 112 seconds, which results in a computed clock rate of 893 kHz. The actual clock frequency is 895 kHz (3579 divided

6800 Monitors

Table 1 compares eleven ROM monitors, with which I am familiar (data for this table was adapted, with permission, from a comparison table published by Gimix):

				NAM		TIMER
(010	0)		ORG		\$0100
0100	CE	0000	START	LDX		#\$0000
0103	86	BF		LDA	A	#\$BF
0105	09		LOOP	DEX		
0106	26	FD		BNE		LOOP
0108	44			DEC	A	
0109	26	FA		BNE		LOOP
010B	86	07	DONE	LDA	A	#\$07
010D	BD	E1D1		JSR		\$E1D1
0110	7E	E0E3		JMP		\$E0E3
				END		
	00	ERRO	R(S) DE	TECT	D	
	00	ERRO	R(S) DE	TECT	ED	

on the CPU board, and substitute a 3.579 MHz color TV crystal instead. Because of the division by 4 in the 6875, the resulting clock speed will be one quarter of that, or just under 900 kHz. Although you could use a 4 MHz crystal instead, 3.579 MHz crystals are inexpensive and easy to obtain (I got mine for 99 cents at a local parts emporium). You could also use 80meter ham crystals around 3.7 MHz, as long as they are the newer, metal-case types, not the old, pressure-mounted ones.

You can easily use a frequency counter to measure the actual clock frequency, but an easier way is to use a calibrated program. Listing 1 is written to run exactly 100 seconds - from the time you start it until it rings the bell on your terminal, if the clock

GMXBUG versions 3.0, 2.0 and 1.0, from Gimix, Inc., 1337 West 37th Place, Chicago, IL 60609. All three versions are designed to be used with the Gimix 6800 board and the Gimix video board. Another GMXBUG is version 3.0/8KP, a special version for non-Gimix CPU boards.

SWTBUG is by Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216.

RT-68 is by Microware Systems Corp., PO Box 4865, Des Moines, IA 50304, and is unique among all of these since it offers real-time capability to switch computer time between a number of tasks, which take turns executing.

MIKBUG is the original Motorola monitor.

SMARTBUG is available from

FEATURE	BUG	BUG V2.	BUG	BUG			SMA- RT BUG	DLE		JOE BUG	SMI- TH BUG	BUG
Monitor size	3K+	3K	2K	1 K	1 K	512		1 K	1 K	2K	2K	3K
ROM Type	′08	′08	′08	′30	′30	′30	816	16 no	′08		816 yes	816
Add to SWTBUG Replace SWTBUG	yes	yes	yes		yes		yes		yes	yes	yes	yes
	10	,	,									
Control port Alt. control port	4L			150	1 C 2 S	10	25	25	08	15 7L	15	15
Other I/O ports	3			OSC	20			7L	15	1	1	2
Video board		GMX								THO		PER
Video format (lines*char)	24x 80	16x	16x							16x	•	16)
(IIIIes+Cilar)	ov	04	01									
MEMORY EXAM entry	M	H	H	Ħ	H	H	H	M	Ħ	M	E	HE
Exam next loc Exam previous	+	+	+	sev ↑	LF	sev	U		sev.	sev ↑	or ↑	se\
Change & advance		#	#	#	1	#	#	#	#	#	#	#
Change, no adv	=#		=#									
Display binary ASCII entry	2	2	2					S			at	ΑI
OTHER MEMORY FUNCT		•										
Hex Dump	D	D	D		B			D			V D	HD
Dump Assy Lang Dump Mach Lang	F							Ε	Т		ь	DE
ASCII Block out	D	D	D									
ASCII Text out	v	X								С	м	OA OM
Move Memory Fill Memory	X Z	Z					I			F	I	FH
Find byte in mem		-		F				1-3		A	F	FI
(#of bytes)	1-3			1				1-3		2	1	1-
Memory test Init Stack Ptr	I	Ţ	I							٧		ĦT
Init IRQ vctr	•							I				
Init NMI vctr	_							N				
DEBUGGING FUNCTION: Set Breakpoint	5 B	В	В	В	В		К			В	1,2	BR
(# of Bks)	4	4	4	1	1		1			1	2	4
Reset Breakpoint		K	K	B	В							BR
Print Brk Locs. Print Registers	P R	P R	P R	R	R	R	R	R	R	R	R	BP RE
Change Registers							yes				yes	
Checksum memory	С	С	C						С			CS SS
Single-Step Hex Arithmetic	A	A	A				T				Ī	33
EXECUTE USER PROGR												
Goto User Pgm	G	G	G	G	G E	G	G J	G	G	G J	G J	60
Jump to User Pgm JSR to User Pgm	J	J	J	J			J			J	J	JU
Cont. Frm Break				G	G					_	K	CO
Jump to COOO ROM Jump to E400 ROM	U	U	U	Z	Esc		4			Z		PD
Jump to E800 ROM								8				
TAPE SAVE/LOAD							į.					
		L	L	L	L	L	L		L	L		LO
Load from tape	L											
Load from tape Load w. offset Punch Tape	L L S	L	S	Р	Р	Р	P		P	P		PU
Load w. offset Punch Tape Punch PC and S9	L	L		P E	P	P	P		Р	E		PU EN
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld	L	L		E	P	Р	P	P,L				
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0	L	L			Р	Р	Р	P,L	P yes	E		
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWTP 5"	L	L		E	P	Р	P	P,L		E T,S		
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst.	L	L S		0	P	P	P	P,L		E T,S	Q	EN
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst.	L	L S		0	P	P		P,L		E T,S D H,W	Q &	EN
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8"	Ls	L S	S	D		P	Q D	P,L		E T,S D H,W	100	FD
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk	L	L S		0	P	P	Q	P,L		E T,S D H,W	100	EN
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr.	Ls	L S	S	D		P	Q D	P,L		E T,S D H,W	100	FD PD
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr.	L S	L S Q	S	D		P	Q D		yes	E T,S D H,W U Z	å	FD PD
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 0n/Off	U	Q U O	U	D		P	Q D		yes	E T,S D H,W U Z O	å	FD PD †S(
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr.	L S	L S Q U O	S	D		P	Q D 4		yes	E T,S D H,W U Z O Q	Н	FD PD +50+51+5
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRI Pause Full/Half Buplex	U I +S I	L S Q U O TS	S U ⊤S	E O D		P	Q D		yes	E T,S D H,W U Z O	å	FD +50 +50 +50 +50 +50 +50 +50 +50 +50 +50
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Buplex Clear Screen	L S U I	L S Q U O	U	D		P	Q D 4		yes	E T,S D H,W U Z O Q	Н	FD PD +50+51+5
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Buplex Clear Screen UTILITY ROUTINES MIKBUG Routines	U I ↑\$ I E 24	L S Q U O TS	S U ⊤S	E 0 D Z C C 22	Esc.	A11	Q D 4 H E/N 37	yes 0	yes ↑E ↑S	E T,S D H,W U Z O Q +S N	8 H 0/N 27	FD +50 +50 +50 +50 CL 16
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Buplex Clear Screen UTILITY ROUTINES MIKBUG Routines Comp. Entry Pts.	U I +S I E 24 24	U 0 +s H E 24	S U ↑S E 4	E 0 D Z C C	17 17	Management	Q D 4 H E/N 37 37	yes	yes ↑E ↑S	ET,S DH,W UZ OQ+S	8 H O/N	FD +50 +51 +51 +51 CL
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Duplex Clear Screen UTILITY ROUTINES MIKBUG Routines COMp. Entry Pts. Extended Rtnes	U I +S I E 24 24	L S Q U 0 ↑S H E	S U ↑S E 4	E 0 D Z C C 22	Esc.	A11	Q D 4 H E/N 37	yes 0	yes ↑E ↑S	E T,S D H,W U Z O Q +S N	8 H 0/N 27	FD +50 +50 +50 +50 CL 16
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Buplex Clear Screen UTILITY ROUTINES HIKBUG Routines Comp. Entry Pts. Extended Rtnes R/T Multi Task OTHER	U I +\$ I E 24 24 Yes	U 0 15 H E 24 Yes	S U ↑S E 4 Yes	E 0 D D Z C 22 22 22	Esc 17 17 17 Yes	A11 A11	Q D 4 H E/N 37 37 Yes	yes 0	yes ↑E ↑S	E T,S D H,W U Z O Q +S N	8 H 0/N 27 0	FD +50 +51 +51 CL 16 16
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Buplex Clear Screen UTILITY ROUTINES MIKBUG Routines Comp. Entry Pts. Extended Rtnes R/T Multi Task OTHER USER Def. SWI	U I +\$ I E 24 24 Yes	U 0 15 H E 24 Yes	S U ↑S E 4 Yes	E 0 D Z C C 22	Esc 17 17 17 Yes	A11	Q D 4 H E/N 37 37	yes 0	yes ↑E ↑S	E T,S D H,W U Z O Q +S N 32 32	8 H 0/N 27	FD +50 +51 +51 CL 16 16
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Duplex Clear Screen UTILITY ROUTINES MIKBUG Routines COMP. Entry Pts. Extended Rtnes R/T Multi Task OTHER User Def. SWI Dumb Terminal	U I +\$ I E 24 24 Yes	U 0 15 H E 24 Yes	S U ↑S E 4 Yes	E 0 D D Z C 22 22 22	Esc 17 17 Yes Yes	A11 A11	Q D 4 H E/N 37 37 Yes	yes 0	yes ↑E ↑S	E T,S D H,W U Z O Q +S N	8 H 0/N 27 0	FD +50 +51 +51 CL 16 16
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Duplex Clear Screen UTILITY ROUTINES HIKBUG ROutines Comp. Entry Pts. Extended Rtnes R/T Multi Task OTHER USER Def. SWI Dumb Terminal Error Detection MEMORY USED	U I ↑S I E 24 24 Yes	U 0 15 H E 24 Yes	S U ↑S E 4 Yes	E 0 D Z Z C 22 22 Yes	Esc 17 17 Yes Yes No	A11 A11 No	Q D 4 H E/N 37 37 Yes No	yes	yes ↑E ↑S	E T,S D H,W U Z O Q +S N 32232	8 H 0/N 27 0	FD +50 +50 +50 +50 +50 +50 +50 +50 +50 +50
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Buplex Clear Screen UTILITY ROUTINES MIKBUG Routines Comp. Entry Pts. Extended Rtnes R/T Multi Task OTHER User Def. SWI Dumb Terminal Error Detection MEMORY USED ROM - Program	U I ↑ ↑ S I E 24 24 Yes Yes E0	U 0 15 H E 24 Yes	S U ↑S E 4 Yes	E 0 D Z Z C 222 Yes E0	Esc 17 17 17 Yes Yes No Yes	A111 No	Q D 4 H E/N 37 Yes No	yes 0	yes ↑E ↑S	E T,S D H,W U Z O Q TS N 322 Yes X	# H O/N 27 0 Yes	FD +50 +50 +51 +51 +51 +51 +51 +51 +51 +51 +51 +51
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Duplex Clear Screen UTILITY ROUTINES MIKBUG Routines COMP. Entry Pts. Extended Rtnes R/T Multi Task OTHER User Def. SWI Dumb Terminal Error Detection MEMORY USED ROM - Program ROM - Vectors	U I ↑S I E 24 24 Yes	U 0 15 H E 24 Yes	S U ↑S E 4 Yes	E 0 D Z Z C 222 Yes E0	Esc 17 17 Yes Yes No	A111 No	Q D 4 H E/N 37 Yes No	yes	yes ↑E ↑S	E T,S D H,W U Z O Q TS N 322 Yes X	8 H 0/N 27 0	FD +50 +50 +51 +51 +51 +51 +51 +51 +51 +51 +51 +51
Load w. offset Punch Tape Punch PC and S9 Binary Pun/Ld Tape on Port 0 DISK BOOTSTRAP SWIP 5" Flex Warmst. SSB 5" SSB Warmst. SSB 8" Percom Disk I/O PORT CONTROL Printer Subr. Call Ext. Subr. Port 1 On/Off Output Wait CRT Pause Full/Half Buplex Clear Screen UTILITY ROUTINES MIKBUG Routines Comp. Entry Pts. Extended Rtnes R/T Multi Task OTHER User Def. SWI Dumb Terminal Error Detection MEMORY USED ROM - Program	U I ↑S I E 24 24 Yes Yes E0 Yes	U 0 15 H E 24 Yes	S U ↑S E 4 Yes	E O D Z C C 22 22 Yes EO Yes	Esc 17 17 Yes Yes No Yes E0 Yes	All All No	Q D 4 H E/N 37 Yes No	yes 0 0	yes ↑E ↑S 14 14 Yes	ET,S DH,W UZ OQ+S N 322 Yes X E0 Yes	# H O/N 27 0 Yes	FD PD +50 +51 +51 +51 +51 +51 +51 +51 +51 +51 +51

Smoke Signal Broadcasting. 31336 Via Colinas, Westlake Village, CA 91361.

DOODLEBUG comes from Computerware Software Services, 656 Lomas De Oro. Olivenhain, CA 92024.

MSIBUG is by Midwest Scientific Instruments, 220 W. Cedar, Olathe, KS 66061.

JOEBURG is written by Joe Pentecost, Marietta, GA, and is distributed by Thomas Instrumentation, 168 8th Street, Avalon, NJ 08202. It is specifically aimed at supporting the Thomas Instrumentation Video Board.

SMITHBUG comes from Ed Smith's Software Works, PO Box 339, Redondo Beach CA 90277.

HUMBUG is my "Monitor to End All Monitors" effort. I will describe many of its routines, with source listings, in this series. A complete listing, however, takes almost 40 pages and can't be reproduced here. Hence, the full source code on disk or cassette, as well as 2708 and 2716 EPROMs, is available from Star-Kits, PO Box 209, Mt. Kisco, NY 10549. This monitor supports the Percom video board.

Monitor Features

Let's examine some of the features of Table 1.

Monitor size. The original MIKBUG occupied half of a 1K mask-programmed ROM and was, therefore, 1/2K in size. All of the newer monitors take up 1K, 2K or 3K. The more memory, the more functions.

ROM type. MIKBUG and SWT-BUG both came on 6830 maskprogrammed ROMs and plug directly into the CPU card. They are identified with '30 in the table, as is RT/68. Most others require EPROM, usually 2708 (labeled '08). Several (listed as 816) are available as either 2708 and 2716.

Add to/Replace SWTBUG. SMITHBUG can be used either by itself or in addition to SWT-BUG (or MIKBUG). DOODLEBUG is not self-contained but must be used along with SMARTBUG. It is available either on SSB disk for use in RAM or along with SMARTBUG in the same 2716. All others are designed to completely replace the usual SWTP monitor.

Ports. This category represents a big difference among the various monitors. The table lists ports on four lines. The control port is the port used for normal monitor communication; an alternate control port is another port that can be used instead of, or in addition to, the main port. Some of the monitors also support additional ports that can be used for program output, and some also support a video board.

The original MIKBUG required a PIA port-in the form of an MP-C card-in port 1. This is shown in the table as 1C (1 stands for port 1. C stands for MP-C. S for MP-S and L for MP-L). This was both a control port as well as the normal program I/O port.

1SC in the SWTBUG column indicates that the main port in port 1 could be either an MP-C or MP-S card. For monitor P. L and E commands, SWTBUG also supports a serial device on port 0.

RT/68 requires an MP-C board in port 1 and can also use an MP-S card in port 2 in addition. SMARTBUG and DOODLEBUG require an MP-S card in port 2. DOODLEBUG also has provisions for a parallel printer on port 7.

GMXBUG is designed for use with the GMX video board for output and requires a parallel keyboard in port 4. It also will support three other I/O ports for program use - an MP-S for tape on port 0, an MP-L for a parallel printer in port 4 or an MP-S for a serial printer in port 3.

JOEBUG works with an MP-S card in port 1 as a control port, but when used with the Thomas Instrumentation Video Board, it will also work with a parallel keyboard on port 7 for input and the video board for output. It can operate with another serial or parallel port for program output.

SMITHBUG uses an MP-S card in port 1 for control but can call a user-written output handler for another output device such as a printer.

HUMBUG works with an MP-S card on port 1 and also supports an MP-S card in port 0, the Percom video board and a user-defined port for output.

The table also lists the number of lines and the number of



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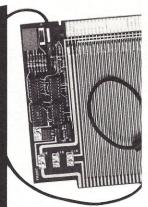
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characters per line for those monitors that support a video board. .

Monitors that do not use a serial input on port 1 introduce one major problem: a lot of software tests the keyboard on port 1 for a break character without going through the monitor. When a different control port is used or a parallel keyboard is used, then all this software has to be patched to work. For instance, the GMXBUG manual contains about 15 pages of patches to various programs so they will run with this monitor. This could lead to a serious incompatibility

This is eliminated with an MP-S card on port 1. Next month I will show users of a video board another way-a special input card that interfaces a parallel keyboard on port 1 in such a way that all software thinks it's a serial keyboard connected via the standard MP-S-to solve this dilemma.

Memory exam functions. All of the monitors examine and change memory contents. In the remainder of Table 1, capital letters identify the monitor command for a particular function. In most of the monitors, memory can be examined or changed with the M command; in SMITH-BUG it is done with the E command: and in HUMBUG it is done with the ME command (HUM-BUG uses two-letter commands; all the others use one letter).

Let's take a look at SWTBUG's entries. M starts the memory exam mode. Several characters allow you to go to the next location. The up arrow (1) allows you to examine the previous location. Entry of a number (shown as # in the table) allows a change. GMXBUG has a few more modes, such as change without advancing, display in or enter binary ASCII characters. SMITHBUG and **HUMBUG allow ASCII character** entry.

Other memory functions. Several monitors allow a hexadecimal, formatted dump of memory contents. SMITHBUG disassembles memory and outputs assembly-language mnemonics; GMX-BUG, DOODLEBUG and HUM-BUG output machine language, with address and one, two or three bytes of instruction per line, GMXBUG also allows a formatted ASCII output, while HUMBUG will dump ASCII text from memory.

The larger monitors provide additional memory functions, including moving a block of memory contents, filling memory with an arbitrary number (such as SWI), finding specified bytes in memory (one, two or three bytes), running a memory test and initializing the stack pointer.

Debugging functions. These are extremely important to assembly-language programmers but may be completely unused by BASIC programmers. Except for MIKBUG and MSIBUG, all other monitors allow the setting of a breakpoint. SMITHBUG allows two breakpoints, while GMXBUG and HUMBUG allow up to four. To keep track of where they are, the latter two monitors can also print out locations of current breakpoints.

When a breakpoint is encountered in a program, all monitors print out the contents of 6800 registers. This printout can also be requested with the R command. SMARTBUG and SMITH-BUG also have specific commands for changing these registers, while DOODLEBUG allows changing the CC register. Additional debugging commands allow computing a checksum of memory contents, single-stepping through programs and performing hex arithmetic.

Execute user program. The two absolute minimum functions of a monitor are changing memory and jumping to a program. Hence, all monitors have a G or GO command to go to a user program. In most of these, address A048/49 is used as the pointer to the program. Several monitors also have a J or JU command to jump to a program without setting A048/49 first. In GMXBUG and HUMBUG, this command actually does a JSR to a user program, so that subroutines can be executed and will return to the monitor when done.

In some monitors, the G command is also used after a breakpoint to continue the program. In others, a different command, such a K or CO, is used.

For use with external ROM programs, several monitors have a command such as SWT-BUG's Z to jump to PROM. Most jump to address C000, though SMARTBUG jumps to E400, and DOODLEBUG jumps to E800.

Tape save/load. All monitors except SMITHBUG provide commands to punch and load tape using the standard MIKBUG format (S1 . . .). SMITHBUG doesn't have this function because it assumes that it is used as an adjunct to another monitor.

SWTBUG and several others have an E or EN command to punch the program starting address (A048/49) and an S9 at the end. SWTBUG also permits a port 0 to be used as an option, while JOEBUG and DOODLE-BUG have binary punch and load routines for speedier operation.

Disk bootstrap. Almost all of the monitors allow disk bootstrapping in one way or another. but for different disks. If you already have a disk, this is important to you. JOEBUG is the most complete in this regard, as it has facilities for both the SWTP mini-floppy disk system as well as the SSB 8 inch floppy and Percom's LFD-400. (Since Percom's LFD-400 DOS is in EPROM at C000, the same command that jumps to user PROM at C000 is used for booting the Percom disk.)

I/O port control. This section lists the commands for controlling additional ports, if any. (†S means control-S.) There are commands for enabling and disabling printer output, as well as for calling a user-written external subroutine. JOEBUG and HUMBUG have a command for turning off port 1 output while letting the video board continue at full speed. In several monitors, †S provides a wait function for stopping output while you read the CRT screen. HUMBUG also has a command for pausing automatically every 15 lines. The full/half duplex command controls echoing of input back to the output device.

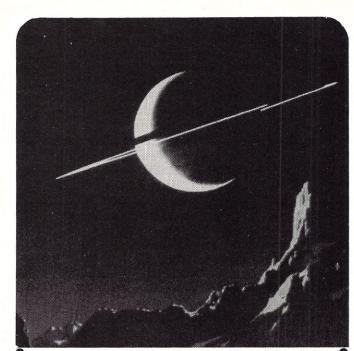
Utility routines. In addition to monitor commands, most monitors have a set of subroutines. such as INEEE, OUTEEE and PDATA, as well as a host of less

common ones, that are generally called by user programs for input and output. The original MIKBUG had several dozen such routines (and associated variables), which are often used by other software. For obvious reasons, other monitors provide the same routines, usually at the same addresses.

The utility routines section of Table 1 shows how many such MIKBUG routines each monitor has, and also whether they have compatible entry points. With the exception of GMXBUG version 1.0 and DOODLEBUG, all other monitors have most of the MIKBUG routines. Only about ten of the MIKBUG routines are commonly used, so most of the monitors will provide this basic core of routines. Likewise, most of the monitors provide these routines at the same entry addresses. The one exception is SMITHBUG, which has no compatible entry points. Keep in mind that SMITHBUG is intended to be used primarily as an addition to another monitor, not as a replacement for it. Hence, it relies on the routines in the other monitor. If SMITH-BUG were used all by itself, major and extensive surgery would be required on other software to change monitor routine calls.

DOODLEBUG has no compatible routines, since it must be used with SMARTBUG and is not self-contained. Some of the monitors, such as GMXBUG, have extended routines not included in MIKBUG. GMXBUG is particularly rich in these, since it has routines to push and pull index register contents and add accumulators to the index register. Any program written to take advantage of these will not run with other monitors. These routines use the SWI instruction and cannot be used with Flex 2.0.

RT/68 is different from all the others in one big way: it supports real-time multitasking. An external clock signal, usually at a fixed rate such as 60 or 100 pulses per second, is connected to the control port to generate interrupts at each pulse; this is called a real-time clock. Each time an interrupt occurs, the program currently running is in-



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terrupted, and control returns back to the "multitasking executive" portion of RT/68.

For each program (task) in memory at the time, there is an entry in an area of the scratch-pad RAM called the "task status table," which contains various operating parameters for up to 16 programs.

Each time that an interrupt causes a jump back to RT/68, the monitor looks at the task status table to see whether the current task should be continued; if not, it determines which other task should be started. Thus, up to 16 tasks can be run. Some of these tasks might be independent programs, while others might be related to other tasks to work on the same problem.

Other. Some other features of the various monitors may be important in some applications. Most monitors allow the SWI instruction to be user-defined; only MIKBUG, RT/68 and SMARTBUG do not allow this. JOEBUG has an operating mode that allows the system to be

used as a dumb terminal on-line to another computer system. RT/68 also has error detection; it will print out an error message if a command is used incorrectly.

Memory used. Most monitors are written to reside at address E000 and up; SMITHBUG starts at F800 because it may be used with another monitor and thus must use different addresses. DOODLEBUG's RAM versions are at either 1C00 or 3C00, and the 2716 version is at E400, which is the next 1K after the SMARTBUG with which it is used. The reset and interrupt vectors are required by the 6800 at addresses FFF8-FFF.

Most monitors require just the standard 128-byte scratch-pad from A000 to A07F; but the more versatile ones require more memory. Thus, GMXBUG uses memory from 6FFF down for a stack; RT/68 requires 12 bytes starting at 0000 only when multitasking (these are not needed in single-task use). HUMBUG requires 128 bytes at D000 in addition to the standard scratchpad at A000.

Finally, JOEBUG is available in an alternate version that has RAM at C000 instead of A000; this version is designed for use with the Thomas Instrumentation CPU board.

HUMBUG

Ever since I put a serial printer on port 0, I have been thinking of modifying my monitor to allow better control over it and also over the Selectric printer I have on port 4. When I recently got a Percom video board, the need to interface it properly to existing software became even more acute. The HUMBUG monitor was the result.

HUMBUG is an extended monitor intended as a SWTBUG/MIK-BUG replacement. My standard version occupies three 2708 EPROMs and requires a separate EPROM board; a 2K version of HUMBUG, which fits into a 2716 EPROM and fits on the MP-A2 CPU board, also exists. This latter version does not have the Percom video driver and also omits the AI, MO and MT commands (see Table 1).

In designing HUMBUG, I had the following criteria in mind:

- SWTBUG subroutine entry points had to be preserved so other programs would run unchanged. SWTBUG scratchpad addresses also had to stay the same.
- 2. I wanted full control over the system from the keyboard, including turning ports on and off in the midst of a program and aborting programs from the keyboard without pushing RESET.
- 3. I needed extended debugging facilities for machine- and assembly-language programming. I was not happy with the way SWTBUG handled breakpoints and stack pointers in user programs, since it would make an occasional annoying error. I also wanted a single-step mode for stepping through programs under test.
- 4. Finally, I expected HUM-BUG to change with time and wanted to make it easily extended to new functions without major rework.

We'll discuss each of these criteria in turn next month.■



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// hat do we want from our computers? Why did we really spend the money for that exotic system that takes up space and causes us to fritter away all our free time?

For those of us who have done it, the answer is so obvious that we wonder why anyone even needs to ask. We bought our computers to have fun! And that answer satisfies us completely. But non-aficionados invariably ask two questions in this order: "How much did it cost?" and "You mean it won't do anything but play

games?" These lines are usually followed by a dour shake of the head.

So we need to have our computers do useful things to satisfy our spouses, nonbelieving friends and other skeptics... especially when they ask how much energy the darn thing wastes!

So here is the answer. Run this program and you can not only show people a useful function of your computer, but analyze your own electricity consumption month by month. Furthermore, as anyone in New England knows, we pay more for power in this region than anyone else in the country, so conservation is vital. Anything that gives us a picture of how much energy we use will contribute to less consumption and more saving.

The Program

The program was written for my 8K PET. In addition to checking my patterns of electricity use, I wanted to accomplish two other things with the program: verify the accuracy of the electric company's calculation of my bill (even their computers have been known to drop a bit!) and learn more about the PET's ability to handle strings and graphics.

The concise computation of the monthly bill is contained in lines 800-1500. The mathematical formulas are derived from the rate sheet available from the power company, and, when rates change, it will be easy to modify lines 800 and 900 to correct the calculations.

Since I pay my monthly bill on a "budget plan" that calls for a level monthly payment of \$139, line 1500 lets me know how much my payment is over/ under the actual amount owed for the month.

When my PET first arrived, I studied the mimeographed instructions for using the cassette recorder to maintain data files on tape and decided this was the way to store my data. It worked fine, as long as I entered all the data at once! But figuring out a way to update the data file each month with consumption figures and the fuel adjustment charge eluded me. I could do it, but not efficiently, and I could not make the data read back fast enough. (The PET puts a long leader at the beginning of each data file, which considerably slows down search and readback of multiple files.) It seemed the only way to do it was to put the data into the program, using DATA statements. Each DATA line sets up a string (A\$) for one month's figures, with the following format: date (mo/yr), space, kilowatt-hours (kWhr) used for general consumption, space, kWhr used for water heating, space, fuel adjustment charge.

The program then asks if you want to read back previous data. This is where you can look at your patterns of consumption to determine if your conservation measures, additional insulation, etc., have been effective or if you need to try harder. You will be asked to specify digital or graphic readback and which month's data you wish to see. Because of the size of the PET's screen, I am limited to 20 months in one run before the data begins to roll off the top of the screen. If you have a bigger screen, change lines 2025, 6025, 7025 and 8025 to whatever limit your terminal sets. If you are printing it out on a hard-copy terminal, you can eliminate the FOR I=1 TO 20-NEXT I loop.

Typing F ends the input cycle. F was not chosen arbitrarily-it stands for "finished."

Program listing. **GOSUB 10000** DATA: N = (same as line number) example: 34 DATA "06/78 1350 620 1.13": N = 34 DIM A\$(N), C(N), P(N), E(N), Y\$(20) FOR A=1 TO N: READ A\$(A): NEXT A C=VAL(MID\$(A\$(N),7,4)) P=VAL(MID\$(A\$(N),12,3)) 1-189 190 195 500 E=VAL(RIGHT\$(A\$(N),4)) F=(C-500)*.0315 + 24.55 G=(P-300)*.0195 + 8.52 800 900 1000 H=((C+P)/100)*E PRINT 1200 T=P+G+H T=INT(100*(T+.005))/100 PRINT "TOTAL BILL IS \$"; T PRINT: PRINT "BUDGET ADJUSTMENT IS \$"; 139-T PRINT: PRINT "BATA READBACK (Y OR N)"; Z\$ IF Z\$ = "Y" THEN 1650 IF Z\$ = "N" THEN PRINT "GOODBYE": END PRINT: PRINT " INPUT ERROR! ! !": GOTO 1550 PRINT: INPUT "DIGITAL OR GRAPHICAL (D OR G)"; Z\$ IF Z\$ = "G" THEN 5000 IF Z\$ = "D" THEN 2000 1300 1400 1500 1550 1600 1630 1650 1700

After the column headings are printed, each Y\$ you input, which is each month/year you want to see, is scanned against the A\$s in memory. When a match is found, the various parts of that A\$ are either printed numerically or converted to a number of dashes for the graphic plots. The program then asks if another run is wanted; if so, the program recy-

A Few Notes

The spaces embedded in the data lines are used as delineators when reading the substrings later. If your data won't read back correctly, make sure you have put in those spaces when entering the data statements. If you change the format of the data lines to use the program for some other purpose, be sure to correct each line that calls out a substring.

The graphics used are directly from the PET's keyboard. The underlining in lines 2130, 6110, 7110 and 8110 is the shifted # character; the dashes used in the plots (lines 6140, 7140 and 8140) are the shifted C; and the X in lines 6130, 7130 and 8130 is the shifted V.

In summary, this program will allow you to keep tabs on your monthly electric bill and compare usage for any series of months desired. It also demonstrates simple techniques for manipulating strings and substrings on the PET and generating simple graphic displays of data contained in memory. I found that the PET's substringhandling capability makes this easy to do.

The program would be easy to modify for other types of data as well, and data strings could be extended to any length within the capacity of your computer. With other kinds of data requirements, it might be easier to make each data statement a shorter string and deal with it as an entity rather than breaking it up into substrings.

I hope it will also demonstrate to nonbelievers that you and your computer can do more than just play ticktacktoe or battleship.

```
PRINT: PRINT " INPUT ERROR!!!": GOTO 1650
PRINT: PRINT "ENTER EACH MONTH/YEAR DESIRED - ENTER
 1710
2000
                       FOR NO MORE DATA NEEDED"
                FOR I = 1 TO 20
INPUT Y$(I): IF Y$(I) = "F" THEN 2100
2025
2050
2075
2100
                PRINT
                                                                            FUEL ALJ. CHG."
2120
2125
                           "MONTH
                PRINT
                                                DSH
                                                               KWH"
                PRINT
2130
2133
2136
2137
                PRINT
                FOR W = 1 TO I
FOR M = 1 TO N
               IF LEFT$(A$(M),5)=Y$(W) THEN C(W)=VAL(MID$(A$(M),7, IF LEFT$(A$(M),5)=Y$(W) THEN P(W)=VAL(MID$(A$(M),12) IF LEFT$(A$(M),5)=Y$(W) THEN E(W)=VAL(RIGHT$(A$(M),
2138
2139
2140
                IF Y$(W) = "F" THEN 6160
PRINT Y$(W); SPC(3); C(W); SPC(3); P(W); SPC(3); E(W)
NEXT W
 2141
2145
2150
2160
               PRINT: INPUT "ANOTHER RUN (Y OR N)"; Z$
IF Z$ = "Y" THEN 1650
IF Z$ = "N" THEN PRINT "GOODBYE": END
PRINT " INPUT ERROR!!!": GOTO 2160
               PRINT " INPUT ERROR! !!": GOTO 2160
PRINT: INPUT "WHICH DATA DO YOU WANT TO SEE (D Q OR F)"; Z1$
IF Z1$ = "D" THEN 6000
IF Z1$ = "F" THEN 8000
PRINT: PRINT " INPUT ERROR! ! "
 2180
2190
 5000
5050
5051
5052
5055
6000
                PRINT: PRINT " INPUT ERROR!!!": GOTO 5000
PRINT: PRINT "ENTER EACH MONTH/YEAR DESIRED - ENTER
                'F' FOR NO MORE DATA NEEDED
                FOR i = 1 TO 20
INPUT Y$(I): IF Y$(I) = "F" THEN 6100
NEXT I
 6025
6050
6075
6100
                PRINT: PRINT "DSH KWH"
                PRINT "MONTH
 6110
                                                  KILOWATT-HOURS"
6120
6125
                PRINT "
                                  1K 2K 3K 4K
TO 40: PRINT "X":: NEXT J: PRINT
 6130
6133
6136
                FOR J = 1
FOR W = 1
FOR M = 1
                                  TO
                IF LEFT(A$(M),5)=Y$(W) THEN C(W)=VAL(MID$(A$(M),7,4))
 6138
                PRINT Y$(W);: FOR R = 3 TO C(W)/150: PRINT "-";: NEXT R: PRINT
 6140
                NEXT W
PRINT: INPUT "ANOTHER RUN (Y OR N)"; Z$
IF Z$ = "Y" THEN 1650
IF Z$ = "N" THEN PRINT "GOODBYE": END
PRINT " INPUT ERROR!!!": GOTO 6160
PRINT: PRINT "ENTER EACH MONTH/YEAR DESIRED - ENTER 'F'
 6160
 6170
 6180
 6190
 7000
                FOR NO MORE DATA NEEDED"
 7025
7050
7075
7100
7110
7120
                FOR I = 1 TO 20
INPUT Y$(I): IF Y$(I) = "F" THEN 7100
                NEXT I
                PRINT: PRINT "QR KWH"
                PRINT
                PRINT "MONTH
                                                  KILOWATT-HOURS (X 100)
 7125
7130
7132
7133
                PRINT "
                FOR J = 1 TO 40: PRINT "X";: NEXT J: PRINT FOR W = 1 TO I
                FOR M = 1 TO N
7136
                IF LEFT$(A$(M),5)=Y$(W) THEN P(W)=VAL(MID$(A$(M),12,3))
7138
7140
               PRINT Y$(W);: FOR R = 6 TO P(W)/22.6: PRINT "-";: NEXT R: PRINT
7150
7160
7170
               PRINT: INPUT "ANOTHER RUN (Y OR N)"; Z$

IF Z$ = "Y" THEN 1650

IF Z$ = "N" THEN PRINT "GOODBYE": END

PRINT " INPUT ERROR!!!": GOTO 7160

PRINT: PRINT "ENTER EACH MONTH/YEAR DESIRED - ENTER

"E" FOR NO MORE DATA NEEDER!
7190
8000
               'F' FOR NO MORE DATA NEEDED"
FOR I = 1 TO 20
8025
8050
8075
8100
               INPUT Y$(I): IF Y$(I) = "F" THEN 8100
               NEXT I
               PRINT: PRINT "FUEL ADJUSTMENT CHARGE"
8110
               PRINT "MONTH
                                                           DOLLARS"
8120
               PRINT "
8125
8130
8133
                                         50
                                                           1.00
                                                                                1.50
                                                                                                     2.00"
               FOR J = 1 TO 40: PRINT "X";: NEXT J: PRINT
8136
8137
8138
8139
8140
8150
               FOR M = 1 TO
               IF LEFT$(A$(M),5)=Y$(W) THEN E(W)=VAL(RIGHT$(A$(M),4))
               NEXT M
IF Y$(W) = "F" THEN 8160
               PRINT Y$(W);: FOR R = 9 TO E(W)*20: PRINT "-";:NEXT R:PRINT NEXT W
8160
               PRINT: INPUT "ANOTHER RUN (Y OR N)"; Z$
             PRINT: INPUT "ANOTHER RUN (Y OR N)"; Z$
IF Z$ = "" THEN 1650
IF Z$ = "" THEN PRINT "GOODBYE": END
PRINT "INPUT ERROR!! ": ": GOTO 8160
REM *** "ELECTRICBILL" O7/22/78  **
REM *** "EY ERIAN S. KLINGER, O.D. **
PRINT CHR$(147)
PRINT "TO ENTER NEW DATA, PRESS 'STOP' AND THEN"
PRINT: PRINT "'LIST-150'. THEN ENTER NEW DATA AND"
PRINT: PRINT "'LIST-150'. THEN ENTER NEW DATA AND"
PRINT: PRINT "UPDATE N. THEN RUN AGAIN AND PRESS ANY"
PRINT: PRINT "KEY TO CONTINUE WITH CALCULATIONS."
GET S$: IF S$ = "" THEN 10005
8170
8180
8190
9998
9999
10000
10001
10002
10003
10004
10005
10006
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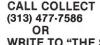
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Superboard II: A Second Look

A year later, it's time for another look at OSI's Superboard II.

Rich Jensen 7612 Havmarket Lane Raleigh, NC 27609

July 1979 Microcomputing article by Bruce Chamberlain about the OSI Superboard II ("OSI's Superboard II," p. 66) provided a good introduction to that 6502-based system: 4K of RAM, 8K ROM with Microsoft

BASIC, 2K ROM monitor, 1K of display buffer RAM, video interface, audio interface and full ASCII keyboard, wired and tested, all for \$279. For \$350, you get the whole thing in a metal case with a power supply. The combination is called the Challenger 1P.

The Superboard met my requirements for hardware and software experimentation. This article describes two hardware modifications I made; it also documents the results of digging useful subroutines and information out of the available documentation and the ROM firmware.

The Hardware

The circuit board is a 10 x 14 inch double-sided board that is prewired for an RS-232 interface, an external 40-pin bus (OSI standard), an audio output and joystick connection (not documented), several unused prototyping sockets and connectors, plus a few goodies I haven't figured out yet.

Experimenting with the electronics is easy. I have modified the video output to work with a Ball monitor and added a switchable tape rate selector for 600 cps, twice the initial speed. I

made both modifications on the existing circuit board. Fig. 1 shows the circuit modifications, and Photo 1 shows the parts placement.

The video modifications provide a longer vertical sync pulse, caused by increasing c8 to .2 uF, and an inverted horizontal sync during vertical sync time-this is the reason for rewiring U70 & U65. Notice that I modified U65 at the socket by soldering small wires on pins 4 and 13 and plugging them into the other socket connections to keep the board changes to a minimum. I split the connection between pins 9, 10 and 11 with an X-acto knife and rewired as shown with fine wire soldered directly to the board. This change requires no more parts than the original circuit and works fine with a normal TV also.

Function	Addre:	ss decimal	Description
scroll screen	BF2D	48941	This is the BASIC print routine. It checks the contents of the accumulator for carriage return, line feed or valid character. It will display the character at the next available position at the bottom line of the screen and scroll all lines up as needed (just as PRINT statements in BASIC). Load accumulator with the character to be displayed and use the JSR instruction 20 2D BF.
initialize cassette interface	FCA6	64678	This routine writes a 3H, 11H to the cassette interface ACIA at address F000H. This resets the ACIA and initializes if for the proper mode and clock division ratio. Use a JSR 20 A6 FC once in your program before you read or write from the tape.
write to cassette	FCB1	64689	This routine writes the contents of the accumulator to the cassette. It checks for write complete and will not return until ready for another character. You can write characters by loading them into the accumulator and using JSR 20 B1 FC without regard to overrunning the interface.
read ASCII from cassette	FE80	65152	This routine reads ASCII data from cassette and turns off high-order bit. Issue JSR 20 80 FE. Character read will be placed in the accumulator. This routine is also self-timing.
convert ASCII to binary	FE93	65171	This routine takes ASCII characters 0-1 and A-F in the accumulator and returns the binary values 0-15. Use JSR 20 93 FE.
write to screen and cassette	FF69	65385	This routine writes to both the screen — it calls the BASIC print routine — and if the contents of the save flag (205H) are nonzero, it writes to the cassette. When it encounters a carriage return it includes 10 nulls after each carriage return. Use JSR 20 69 FF.

With the above routines you can start writing full machine-language programs that consist mostly of JSRs to the existing monitor code.

Table 1.

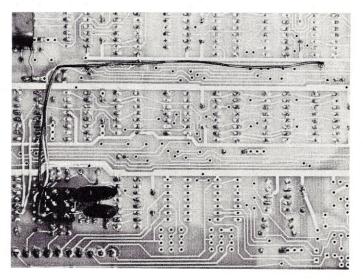


Photo 1. Parts placement.

This modification is only required for a monitor without internal sync oscillators. A normal TV will work fine unmodified with a video converter. A external circuit to do the same thing is described in the original reference.

The cassette speed modification is simple and worthwhile if you become impatient loading an 8K program from the tape. I broke down and bought the 4K of additional RAM that is presocketed on the board. The switch selects the next higher clock signal from the master divider chain to provide a 16 x clock of 9600 Hz rather than 4800 Hz. Wire is routed from the nearest point on the board that provides the C3 signal. This signal goes to a double-pole, double-throw switch which selects either C3 or C4 while selecting the proper capacitor to provide receive timing. The modification doubles the maximum audio frequency to 4800 Hz on the tape instead of the 2400 Hz now used.

CX halves the timing rate of the one-shot U69 to decode the new signal properly on receive. I have had no error rate problems with my low priced Sankyo recorder and cheap tape. I suggest you resist the temptation to simplify the circuit any further by eliminating the switch-selectable 300 Hz rate. Someday you may want to buy a prerecorded program which has been loaded at that rate. Someone with a little soldering experience can easily make the tape modification. The video interface requires good eyesight, and a steady hand to cut and resolder the connections on IC U70.

The Software

Being of the "old school," I wanted to write and execute machine-language code. This is almost always the fastest way to do things; sometimes it is the only way. The 65 V ROM monitor that comes with the system contains functions to allow you to display and modify the contents of RAM storage directly from the keyboard. You key in a hex address and the contents are displayed in hex on the monitor. It also provides functions to load a

machine-language program in the special monitor format from the audio cassette. The documentation does not tell you how to create the tape, however! See Fig. 2 for a BASIC program to create a monitor input tape.

My first weeks on the system were devoted to using the monitor to display itself and laboriously writing down and decoding all 2000 bytes. This brought me a wealth of usable subrou-

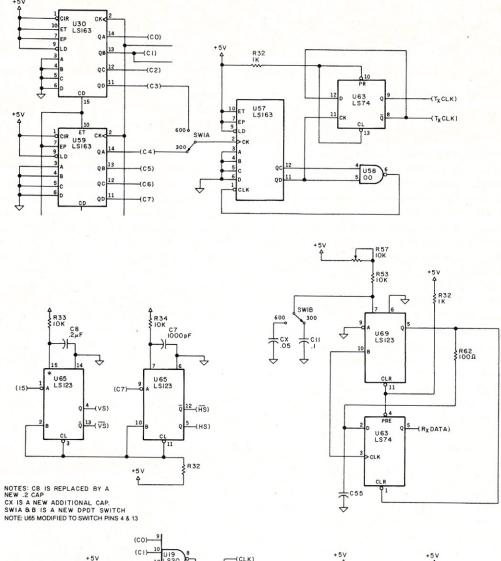
tines that could be called from BASIC or machine-language programs. These routines are debugged, take no additional storage and are always in the system. I've documented some of the most valuable routines and included their location addresses along with some examples of their use.

Problems and Solutions

You will probably need to

know how to use machine-language subroutines from a BA-SIC program. The first problem is entering the machine-language code into the system, if it's not already there. Fig. 3, lines 1-3, shows a BASIC routine to read a data statement and poke the contents into a series of storage locations where it will run.

This is the easiest approach for a routine you want to store



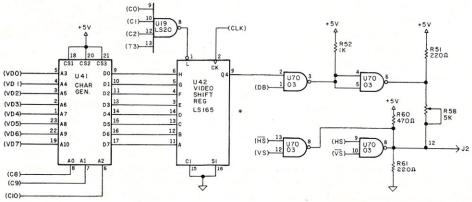


Fig. 1. Circuit modifications.

```
5 DIMA A$(255)
10 FOR X = 1 TO 255
20 INPUT A$(X)
30 IF A$(X) = "XXX" GOTO 41
40 NEXT
41 SAVE
42 PRINT "TURN ON TAPE RECORDER TO RECORD"
43 INPUT "HIT ANY KEY TO CONTINUE"; B$
44 FOR Y = 1 TO 5000:NEXTY
45 X = X - 1
46 FOR W = 1 TO X
47 PRINT A$(W)
49 NEXTW
50 LOAD
55 PRINT "SAVE COMPLETE"
60 END
? .0222
? /20
? 05
? AE
? etc
? XXX
will load 0222 with 20.05 AF etc under monitor control
```

Fig. 2. BASIC program to create monitor format tape.

with the main program. The secret is to convert the hexadecimal machine codes to decimal data for use with POKE statements. The elegant way is to write a BASIC program that converts hexadecimal to decimal and use the program for conversion. The alternate way is to look it up one byte at a time in a conversion table. You may want to use the monitor facility to key in the subroutine directly the first time for testing.

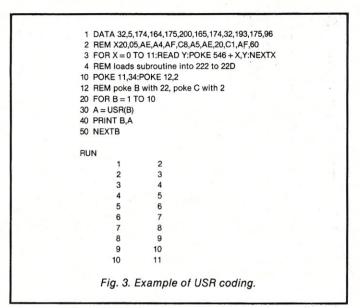
Now that you have the program in storage you must set up pointers to the program address and then execute a USR(X) statement in BASIC to cause a jump-to-subroutine (JSR) instruction to occur. The question is, where does it jump to? The OSI reference manual says you must load address 23EH and 23FH with the address of your subroutine. This doesn't work on my system, but loading address BH and CH does. Line 10 of Fig. 3 pokes this location with the decimal address of the subroutine. You or the program must do this before the USR is issued. You may pass a parameter to the subroutine as the value of X in the USR(X) statement. This value, in turn, passes to the subroutine in storage locations AFH and AEH if it calls the routine pointed to by 6H and 7H (AE05H in line 222 of Fig. 4).

The subroutine can pass a

value back to the basic program by calling the routine pointed to by 8H and 9H (AFC1H). The value will return to BASIC as the value of AH in the statement A = USR(X). For multiple values or as an alternate technique, you can pass value back to BA-SIC by setting a fixed storage location and examining the contents with a PEEK statement.

This sounds complicated, but by using the system manuals and Fig. 4, you should be able to work out what is going on. The example passes a number to the subroutine, which adds one to the number and passes the result back. Not very sophisticated, but it proves the linkage works, and you can go on from

Next, decide where the subroutine is located in storage. If you are running BASIC with the machine code as a subroutine, you normally reserve an area in high core large enough for the subroutine to fit. The basic program loads into memory starting at address 0300H to high memory. You indicate to the start-up routines how much storage you want BASIC to use by responding to the D/W/C/M? with C. Then answer "memory size?" with a value that equals your user RAM (4096 in the initial system) minus the number of bytes you want to set aside. The problem is that you will have to do this every time you cold-start



the system and run this program.

A Trick

Hex locations 0222 to 02FA are unused by either BASIC or the system code. You can fit 216-byte subroutines into this area and not have to answer properly every time you want to use the program. Fig. 3 has an example of a subroutine loaded into this free area.

Now that you know how to use subroutines with the OSI machine, look at some that are already coded for you in the monitor and BASIC ROM, Located at FEEDH is a routine to read ASCII characters directly from the keyboard. See Fig. 5 for an example. Using the routine this way in lieu of an INPUT state-

ment, you can enter data into the program without causing the screen to scroll and ruin the graphics display. This example also shows use of the ASCII-tobinary conversion subroutine at FE93H. Without the JSR to this routine you get the ASCII character values for the key pressed: with it you get the numeric values 1 to 15.

Another method explained in the OSI manuals is to do a PEEK at decimal 57088 (the keyboard address) and a whole series of IF statements to decode the non-ASCII results. This uses more storage space and execution time that the machine-level subroutine does. Table 1 contains a list of some subroutines, with their addresses and a description of their function.

```
222 20 05 AE
                 jump to subroutine pointed to by 6,7 AE05
    A4 AF
                 LDYZP get low order parameter from 00AF
227
    C8
                 INY add 1
    A5 AE
                 LDAZP get high order parameter from 00AE
    20 C1 AF
                 JSR to subroutine pointed to by 8.9 AFC1
                 RTS return to BASIC program
```

Fig. 4. Machine-language subroutine used above.

```
222
    20 FD FF
                 JSR to FFFD "read ASCII"
225
     20 93 FE
                  JSR to FE93 "convert ASCII to binary"
228
     A8
                  TAY move char to Y reg to return to BASIC
     A9 00
229
                  LDAIM 0 A reg
22B
     20 C1 AF
                 JSR routine to return char to BASIC
                  RT3 return
```

Fig. 5. Machine-language subroutine to read binary numbers from keyboard.





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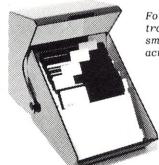
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SORTIT: A Sort Program

SORTIT enhances two of the author's previous programs: SCREEN and FILEIT.

Forest E. Myers 5114 Garnett St. Shawnee, KS 66203

Several months ago I introduced two programs to create, manipulate and retrieve data files. The first program, titled SCREEN, appeared in the April 1980 issue. This program was used to define data fields within a record. The second program, called FILEIT (May 1980 issue), created, modified and retrieved information from data files. The purpose of this article is to introduce another program, SORTIT, which enhances the usefulness of the above programs.

SORTIT is a multikeyed sort program designed to sort data files generated by FILEIT. As was the case with SCREEN and FILEIT, SORTIT is written in Business BASIC, an interpreter sold by Microworks of Cincinnati OH.

Sort Levels

SORTIT supports up to five levels of sort in either ascending

or descending order. The order of sort, however, must be the same at all levels. This means that higher-level sorts cannot be sorted one way, for example, ascending order, while lower-level sorts are sorted in another, for example, descending order.

The best way to explain the sort level concept is by an example. Assume you are working in the personnel department of a small company. On the company's microcomputer you have developed a personnel file using a version of FILEIT. In the personnel file you created, you have captured information on employee name, address, department, job title, home phone, sex, marital status, children, date of employment, previous employer and current office telephone number.

One day you walk into the office, where an employee is groaning over the prospects of the annual effort to put out the company telephone directory. Although there are only 100 employees in the company, they are forever changing offices and telephone numbers. It is always a mess to keep things in order,

and a last-minute update causes havoc.

After listening to this, you think of your personnel file and the information kept in it. You then suggest that there might be a way to ease the employee's pain: use the information in the personnel file. Just reorder the file so a directory can be generated from it.

To generate the directory, you decide a two-level sort is needed. The first sort level, or key, is the employee's last name. The second sort level is the employee's first name. Once sorted using this scheme, the file will contain the names of the employees in alphabetical order by last name, and within each last name employees will be ordered alphabetically by first name. After the file is sorted, the file retrieval option of FILEIT can be used to print out the newly sorted file.

Although the example presented was originally intended to describe the concept of sort levels, it also demonstrates how files intended for one purpose may be used to meet others. SORTIT, therefore, offers the ability to extend file use. As such, it offers savings in time and money.

Operation

When SORTIT is first run, it asks for the number of sort levels, or keys, to be used. A number between one and five must be entered. After the number is entered, SORTIT asks for the order of sort. If the file is to be sorted in ascending order, a "one" is entered. Entering a "two" results in the file being sorted in descending order. SORTIT then reminds the user that a number between one and the number of keys specified be placed after the requisite number of data fields serving as sort criteria.

As a prompting device for sort level specification, SORTIT presents a FILEIT data entry screen. Recall that this screen consists of labels identifying data fields within a record and a series of small x's after each label showing the specified length of each data field. Instead of entering data after each label, the user enters a single digit, from one to five, after the labels to serve as sort criteria. If a given label is not to serve as a sort criterion, a carriage return is entered in response to the prompting question mark. This will move the prompt behind the next label on the screen.

Once all sort keys have been entered, SORTIT asks for the name to be given the sorted file. After the name is entered, SORTIT reads through the file to be sorted. From each record, SORTIT extracts the fields serv-

Program listing.

```
DIN A$(256),B$(10),C$(10),E$(512),C(60)
20
   DIM R(60),L(60),F$(256)
30
   DIN 6$(256),T$(10),B(60)
40
   BIM D(60)
   #"" : FOR I=1 TO 7 : #" "
50
                              : NEXT I
                               SORT PROGRAM
60
70
                                 08/14/79
   REM INITIALIZE STRINGS BEFORE FIRST USE -- A REQUIREMENT
80
   REM OF BUSINESS BASIC
         " : FOR I=1 TO 8 : AS=AS+AS : NEXT I
    A$="
    B$=A$(1,10) : C$=B$ : E$=A$+A$ : F$=A$
    GS=AS : TS=CS
120
    FOR I=1 TO 5 : #" " : NEXT I
    INPUT "Enter name file to be sorted ", B$
    IF LEN(B$)<>6 THEN #"Only six characters are allowed " : GOTO 140 .
```

ing as sort criteria and places them according to the order specified by the user in sort string S\$.

The data field given a value "1" by the user will be put into the sort string first. The field given a value of "2" will be placed in the sort string next and so on. The effect of this is to make the data field given a value "1" the primary sort field, such as employee's last name was in the example. Each higher numerical value specifies another sort level. In the example, the employee's first name would have been given a value "2," resulting in the first names' being sorted in order within each last name, e.g., Myers Forest, Myers Jaime, Myers Jennifer and so on.

By extracting only that portion of the record used for sorting purposes, you can save memory space. At the time of extraction, the block and record from which the sort data were extracted are also placed in the sort string. This allows retrieval of the entire record once the sort is completed. Once all records have been read, SORTIT reorders the sort string according to the specified sort criteria.

When the sort is completed, SORTIT then uses the previously stored block and record addresses to read in the entire record. This information is then output to the file specified as the sorted file. It should be noted that SORTIT will not output a record until a data block is filled, then the whole block is output. This saves diskette space.

When SORTIT completes the sorting process, a sorted file will be created. It will be identical to the original file, except ordered according to user specifications.

The source listing for SORTIT is included. Remark statements have been provided to act as a guide. I hope these will ease the burden of following the program.

In summary, I wrote SORTIT to enhance the capabilities of FILEIT. By providing the facility for sorting FILEIT data files, the usefulness of these files has been extended.

1080

```
160 B$=B$+".DA"+CHR$(0)
    INPUT "Enter disk drive number where file can be found ",D
170
    IF O<0 OR D>1 THEN #"Only 0 or 1 is allowed " : GOTO 170
180
    INPUT "Enter name to be given sorted file ",T$
190
    IF LEN(T$)<>6 THEN #"Only six characters allowed " : 60TD 190
200
210
     T$=T$+".DA"+CHR$(0)
     IF T$=B$ THEN #"Sorted file name must be different than source file name. "
220
230
    IF TS=BS THEN 190
     INPUT "Enter disk drive number where sorted file is to be written ", DO
240
     IF DO(O OR DO)1 THEN #"Only O or 1 is allowed" : GOTO 240
250
     REM THE FORMAT FOR THE OPEN STATEMENT IS A AS FOLLOWS
260
              THE 2 REPRESENTS THE LOGICAL FILE NUMBER. FURTHER
270
              REFERENCES TO THE FILE FOR I/O ARE DONE THROUGH THIS
280
     REN
290
              NUMBER.
     REM
300
     REM
              THE "E" IS A RETURN CODE VARIABLE. EXAMINATION OF
310
              THIS VARIABLE LETS YOU KNOW IF I/O OPERATIONS TO THE
320
              DISK WERE CARRIED OUT CORRECTLY.
     REM
330
     REH
              B$ IS THE NAME GIVEN THE FILE PLUS ANY APPENDED FILE
              EXTENSION. A CHR$(0) IS REQUIRED TO BE ADDED.
340
     REN
              THE 2 AFTER THE B$ REPRESENTS THE TYPE OF FILE OPERATION
350
              TO BE DONE. A "1" IS AN OUTPUT OPERATION ONLY.
360
     REN
              "2" IS AN INPUT OPERATION ONLY. A "3" IS INPUT AND
370
              OUTPUT OPERATION TO DISK.
380
     REM
              THE D REPRESENTS THE DRIVE NUMBER WHERE THE SPECIFIED
390
     REN
              FILES MAY BE FOUND.
400
     REM
410
     REN
              ANOTHER VARIABLE MAY BE ADDED AFTER THE DRIVE DESIGNATOR.
              THIS VARIABLE IS USED TO INDICATE THE NUMBER OF BLOCKS OF DISKETTE SPACE THE FILE WILL REQUIRE.
420
     REN
430
     REH
440
     OPEN (1,E,B$,2,B)
450
     IF E>=1 THEN 2370
     BET (1,E,A$,0)
460
470
     IF E>=1 THEN 2370
     CS=AS(241,242) : CONVERT CS TO Z : REM Z=NUMBER OF LABELS
480
     C$=A$(243,244) : CONVERT C$ TO L1 : REN L1=1ST SCREEN LINE
490
     C$=A$(245,246) : CONVERT C$ TO B1 : REM RECORDS PER BLOCK
500
     C$=A$(247,249) : CONVERT C$ TO D : REM D=LENGTH OF RECORD
510
     C$=A$(250,252) : CONVERT C$ TO Z3 : REM Z3=NUMBER OF RECORDS
520
530
     C$=A$(253,255) : CONVERT C$ TO R : REM R=MAX NUMBER OF RECORDS
     REN FIGURE NO. OF BLOCKS NEEDED FOR SORTED FILE. IF A>O
     REM THEN A PARTIAL BLOCK IS NEEDED THEREFORE BUMP BLOCK
     REM COUNTER.
570
     I2=INT(R/B1) : A=R-I2*B1 : IF A>0 THEN I2=I2+1
     REM 12 IS BLOCK COUNTER. 4 BLOCKS ARE ADDED FOR HOUSEKEEPING REH BLOCKS PLACED IN FRONT OF THE FILE.
580
590
600
     12=12+4
610
     OPEN (2.E.T$.3.D0.12)
620
     FOR I=1 TO Z
       C$=A$(I*2-1,I*2) : CONVERT C$ TO L(I) : REM LABEL LENGHTS
630
       C$=A$(119+I*2.120+I*2) : CONVERT C$ TO B(I) : REM DATA FIELD LENGTHS
640
650
       NEXT I
     REN READ IN LABELS AND PUT THEN IN ES.
660
670
     FOR I=1 TO 2
       GET (1,E,A$,I)
680
690
       IF E>0 THEN 2370
700
       E$(I*256-255,I*256)=A$
710
       NEXT I
720
     BET (1,E,A$,3)
     IF E>0 THEN 2370
750
       C$=A$(I*2-1,I*2) : CONVERT C$ TO R(I) : REM CURSOR ROW ADDRESSES
760
       C$=A$(119+I*2,120+I*2) : CONVERT C$ TO C(I) : REN CURSOR COLUMNS
770
       NEXT 1
780
    REM SORT KEY SPECIFICATION ROUTINE
790
     FOR I=1 TO 5 : #" " : WEXT I
800
     INPUT "Enter number of sort keys (5 maximum) ",KO IF KO>5 THEN #"5 is maximum sort keys allowed " : GOTO 810
810
820
     INPUT "Order of sort 1. Ascending 2. Descending ",00 #"Place a number 1 thru ";KO;" after labels that are to serve"
830
840
    #"as sort keys. "
#" " : IMPUT "Press return to continue ",C$
850
860
     GOSUB 2740
870
     #"Enter sort key number at ? above ";
880
890
     K9=0
     FOR I1=1 TO Z
900
       REM POSITION PROMPTING ? ONE SPACE AFTER LABEL.
910
920
       CURSOR R(I1).C(I1)+L(I1)
       REM HAVE USER INPUT SORT KEY NUMBER. A VALUE BETWEEN 1 AND 5.
930
       REM A STRING VARIABLE IS USED TO ALLOW ENTRY OF A CARRIAGE
940
950
       REM RETURN TO REPOSITION ? BEHIND NEXT LABEL.
960
       6%=F% : REM NULL OUT 6%. NOTE F% IS USED ONLY TO NULL OTHER STRINGS
970
       INPUT1 6$(I1,I1)
980
        REN BLANK OUT X'S AFTER NUMBER OR CR ENTERED
990
1000
        Z2=D(I1)-1 : FOR Z5=1 TO Z2 : #" "; : NEXT Z5
        REM THE NEXT LINE GOES BACK AND BLANKS OUT THE LEFT OVER
1010
        REM PROMPTING ?
1020
        CURSOR R(I1),C(I1)+L(I1) : #" ";
IF G$(I1,I1)=" " THEN 1150
1030
1040
1050
        C$=6$(11,11) : CONVERT C$ TO A0
1060
        K9=K9+1
        REM COUNT THE NUMBER OF SORT KEYS ENTERED (K9)
1070
        REM PLACE SORT KEY VALUE ENTERED BY USER FOR LABEL INTO O()
```

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```
1090
        REM PLACE LABEL'S RELATIVE POSITION INTO V(). WITH THIS
        REM SCHEME, THE LABELS ON THE SCREEN CAN BE GIVEN ANY VALUE
1100
        REM FROM 1 TO 5 WITHOUT CONCERN ABOUT THE ORDER OF LABEL
1110
1120
        REN APPEARANCE ON THE SCREEN.
1130
        0(K9)=A0 : V(K9)=I1
        IF K9=KO THEN EXIT 1230
1140
1150
        MEXT II
1160
      CURSOR 15,0
1170
      CURSOR 15.0
1180
      IF K9<K0 THEN #"Not enough sort keys specified "
1190
1200
      FOR CO=1 TO 500 : # : NEXT CO
1210
      GOTO 780
1220
      REM
      GOSUB 2630 : REN PUT THE SPECIFIED SORT KEYS INTO ORDER
1230
1240
      G$=F$
      REM DETERMINE THE TOTAL LENGTH OF THE SORT KEYS SPECIFIED.
1250
1260
      FOR I=1 TO KO
        H=H+D(V(I))
1270
        NEXT I
1280
      REM ADD SIX TO TOTAL SORT KEY LENGTH (U) FOR BLOCK AND RECORD
1290
      REM BESIGNATOR.
1300
      U0=U+6
1310
      U1=U0+Z3
1320
      IF U1>2048 THEN #"Not enough room to sort file " : END
1330
      FOR I=1 TO KO
1340
1350
        D3=0
        REM CALCULATE THE BEGINNING AND ENDING POSITION FOR EACH
1360
        REM DATA FIELD SPECIFIED BY THE USER AS A SORT KEY. THE
1370
        REM DATA FIELD WAS SPECIFIED WHEN THE USER PLACED A NUMBER
1380
        REM BEHIND A LABEL ON THE DATA ENTRY SCREEN.
1390
        FOR J=1 TO V(I)
1400
          D3=D3+D(J)
1410
1420
          NEXT J
1430
        BO(I)=D3-B(J-1)+1
1440
        EO(I)=B3
1450
        NEXT I
      REM INITALIZE SPACE ON THE DISKETTE FOR THE SORTED FILE
1460
      REM CLEAR SCREEN, HOME CURSOR AND DISPLAY MESSAGE #"" : #"Blanking out diskette for sorted file "
1470
1480
      FOR ZO=1 TO I2
1490
        PUT (2,E,F$,Z0)
1500
1510
        NEXT 70
      REM TRANSFER HOUSEKEEPING BLOCKS TO FRONT END OF SORTED FILE
1520
1530
      FOR Z0=0 TO 3
1540
        GET (1,E,A$,Z0)
        PUT (2,E,A$,Z0)
1550
        NEXT ZO
1560
1570
      UNDIN E$,C,R,L,B,R8,L8,T3,F
      REM S$ IS REFERRED TO AS THE SORT STRING. IT IS INTO THIS
1580
      REM STRING THAT THE VALUES FOR THE SORT KEYS ARE TAKEN FROM
1590
1600
      REM EACH RECORD AND PLACED FOR SORTING.
1610
      DIM S$(2048)
      S$=" " : FOR I=1 TO 11 : S$=$$+$$ : NEXT I
1620
      Z4=0
1630
      FOR B=4 TO 12
1640
        GET (1,E,A$,B)
1650
        IF E>1 THEN #" GET ERROR " : STOP
1660
1670
        FOR J=1 TO B1
          Z4=Z4+1 : IF Z4=Z3+1 THEN EXIT 2030
1680
1690
          X6=0
1700
          REM Z4 SERVES AS A RECORD COUNTER
          REM X8 HOLDS THE BEGINNING POSITION OF FIELD SERVING AS SORT KEY
1710
1720
          REM X7 HOLDS THE ENDING POSITION OF FIELD SERVING AS SORT KEY
          REM X6 HOLDS THE SUM OF THE SORT KEY LENGTHS
1730
1740
          REM X AND Y ARE USED TO POSITION SORT DATA IN THE SORT STRING.
1750
          REM KO HOLDS THE NUMBER OF SPECIFIED SORT EKYS
          REN WITH EACH PASS THROUGH THE LOOP, THE SORT KEY INFORMATION
1760
          REM IS EXTRACTED FROM THE DATA RECORD AND PLACED IN THE SORT
1770
          REM STRING. THE SORT STRING IS THEN SORTED.
REM BY USING THIS APPROACH ONLY THE SORT KEY ARE IN MEMORY.
1780
1790
          REM THIS ALLOWS SORTING A MUCH LAGER DATA FILE WITHOUT HAVING
1800
1810
          REM TO SEGMENT IT.
1820
          FOR I=1 TO KO
            X=Z4+U0-U0
1830
            Y=E0(I)-B0(I)
1840
            X8=J*D-B+B0(I)
1850
            X7=J+B-D+EO(I)
1860
1870
            X6=X6+E0(I)-B0(I)+1
            REM PLACE PORTION OF RECORD SPECIFIED AS SORT KEYS INTO SORT
1880
            REM STRING.
1890
1900
            $$(X+X6-Y,X+X6)=A$(X8,X7)
1910
            NEXT I
          REM PUT BLOCK AND RECORD IDENTIFIERS INTO SORT STRING
1920
1930
          REM ONCE SORT STRING IS SORTED INTO ORDER, THE BLOCK AND
1940
          REM RECORD INFORMATION WILL BE USED TO GET ENTIRE RECORD
1950
          REM FROM SOURCE FILE AND WRITE IT OUT TO SORTED FILE.
1960
          CONVERT B TO C$(###)
          S$(Z4*U0-5.Z4*U0-3)=C$
1970
1980
          CONVERT J TO C$(###)
1990
          S$(Z4*U0-2,Z4*U0)=C$
2000
          NEXT J
        NEXT B
```

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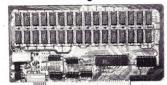
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```
2020 E1=Z3
2030
      GOSUB 2430
2040
      FOR I1=1 TO Z3
2050
        I0=I0+1
        R2=INT([1/R1)
2060
2070
        A=I1-B2+B1
        IF A>0 THEN B3=B2+1
2080
        IF A=0 THEN A=B1
2090
        B4=B3+3
2100
2110
        C$=$$(I1*U0-5,I1*U0-3)
        CONVERT CS TO B
2120
        C$=$$(I1*U0-2,I1*U0)
2130
        CONVERT C$ TO R
2140
        REM B IS BLOCK IDENTIFIER TAKEN FROM SORT STRING. IT IS
2150
        REM USED TO GET FULL RECORD INFORMATION FROM SOURCE FILE. REM R IS NOW USED TO POINT TO SOURCE RECORD IN BLOCK.
2160
2170
        REM ONCE THE SOURCE FILE BLOCK IS READ, THE APPROPRIATE
2180
        REM IS PLUCKED FROM AS AND PLACED INTO GS
2190
        GET (1.E.A$.B)
2200
        6$(A*D-(D-1),A*D)=A$(R*D-(D-1),R*D)
2210
        REM IO IS USED TO KEEP TRACK OF THE NUMBER OF RECORDS
2220
        REM PLACED INTO GS. ONCE THE COUNT IO EQUALS THE BLOCKING
2230
2240
        REN FACTOR B1, A FULL BLOCK IS WRITTEN TO THE DISKETTE.
        IF 10<B1 THEN 2290
2250
2260
        PUT (2,E,G$,B4)
2270
        65=FS
2280
        I0=0
2290
        NEXT II
2300
      IF 6$=F$ THEN 2320
2310
      PUT (1,E,6$,B4)
2320
      #"" : CURSOR 7,5 : #"Sort completed"
2330 FOR I=1 TO 500 : # : NEXT I
2340 CLOSE (1,E) : CLOSE (2,E)
2350
      #"****** End of processing *******
2360 END
2370
      REM ERROR ON DISK ROUTINES
      #"Error code is ";E
2380
      IF E>O THEN #"ALL FILE HAVE BEEN CLOSED"
2390
2400 IF E>0 THEN CLOSE (1,E) : CLOSE (2,E)
2410
      STOP : RUN#0."DB0001"
2420
      END
2430
      REM SORT ROUTINE BEGINS HERE -- BUBBLE SORT
2440
      E1=Z3
2450
      CURSOR 8,10 : #"SORTING "
      FOR A=1 TO E1-1
2460
        FOR B0=A+1 TO E1
2470
2480
          X=A+U0-U0+1
2490
          X9=B0+U0-U0+1
2500
          IF 00=2 THEN 2530
2510
          IF S$(X,X+U-1)<S$(X9,X9+U-1) THEN 2570
2520
          60TG 2540
2530
          IF S$(X,X+U-1)>S$(X9,X9+U-1) THEN 2570
2540
          6$=$$(X,X+U0-1)
          $$(X,X+U0-1)=$$(X9,X9+U0-1)
2550
2560
          S$(X9,X9+U0-1)=G$
2570
          NEXT BO
        NEXT A
2580
2590
      B=B0
2600
      G$=F$
2610
2620
      RETURN
      REM SORT ROUTINE
2630
2640
      E1=K0
2650
      FOR A=1 TO E1-1
2660
        FOR B0=A+1 TO E1
          IF 0(A)<0(B0) THEN 2710
2670
          T=0(A) : T1=V(A)
2680
2690
          O(A)=O(BO) : V(A)=V(BO)
2700
          O(BO)=T : V(BO)=T1
2710
          NEXT BO
2720
        NEXT A
      RETURN
2730
2740
      REM SCREEN PRINT ROUTINE
2750
      #"" : REH CLEAR SCREEN AND HOME CURSOR WITH #"CNTL L"
2760 D1=0
2770 J1=1
2780 FOR I1=1 TO Z
2790
        CURSOR R(I1),C(I1)
2800
        K1=J1+L(I1)-1
2810
        #E$(J1,K1);
2820
        J1=K1+1
2830
2840
        D1=D1+D(I1)
2850
        FOR M1=1 TO D(I1)
2860
          #"x":
          NEXT NI
2870
2880
        NEXT I1
      CURSOR 15,0
2890
2900
                                                               ";
      CURSOR 15.0
```

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A Line Editor For Benton Harbor **BASIC**

This program gives any Heath tape-based interpreter line-editing capabilities.

James F. Teixeira 62 Churchill St. Sudbury, MA 01776

have been using a Heathkit H8 system for nearly a year and am generally impressed with the quality of their design, both hardware and software. Some observers have stated that Heath's BASIC is inferior to others available-Microsoft BASIC is often cited as the top choice-but in many ways Heath outperforms its competitors. Features such as command completion, error detection during input, versatile tape routines and, of course, excellent documentation are among its better attributes.

However, Heath's BASIC does lack a line-editing capability. Once a line of text has been entered via a carriage return, it can be modified only by manually reentering the entire line with the change. To make matters worse, based on the laws of probability, the longer lines have more chance for er-

The program described here adds a useful line-editing capability to any of Heath's tape-based BASIC interpreters. The technique used is general enough to be applied to other BASIC programs if certain key memory locations can be determined.

Programmer interaction with EDIT is simple yet versatile. EDIT operates on the last line of text sent to the terminal. Performing the LIST command in BASIC on the desired line number will set this up. Then pressing the ESC key will activate the editor, which will wait for you to enter a search character. The line of text being edited will be sent to BASIC up to and including the search character, and EDIT will enter the modify mode. You can now talk directly to BASIC, just as if you had

manually typed in the text up to the cursor position. Text may be deleted to the left of the cursor and added to the right.

When the modification is complete, you can choose to either perform another ESCsearch sequence to edit further down the line or type a carriage return to enter the rest of the line from the search character onward. Also, if the stopping place is not the first occurrence of the search character, multiple ESCsearch inputs can be used to position the cursor.

To illustrate this process, the following line:

*100 PRINT "THIS IS A LINE EDITOR" will be changed to:

*100 PRINT "THIS IS THE LINE EDITOR": GOTO 10

After first performing the LIST 100 command to get line 100 as the last line displayed, an ESC followed by an A is entered, and the following will result:

*100 PRINT "THIS IS A

The cursor will stop after the A. Entering a back space and THE will give:

*100 PRINT "THIS IS THE

An ESC followed by a quotation

mark (") will move the cursor to the end of the line:

*100 PRINT "THIS IS THE LINE EDITOR" Now, entering: GOTO 10, followed by a carriage return, will complete the edit:

*100 PRINT "THIS IS THE LINE EDITOR": GOTO 10

Note that a carriage-return entry at any point in the process will always send the rest of the line to BASIC.

This editor also allows the line number to be changed using the same editing procedure described in the above example. The search character would be the last digit of the line number. A series of back spaces followed by the new line number and a carriage return will enter the text with the new number. This will not change the original line in memory, which can either be deleted or left in if a duplicate line of text is needed.

How EDIT Works

To understand how EDIT works first requires an understanding of Heath's Console Driver routine. This is the program that is called by all of

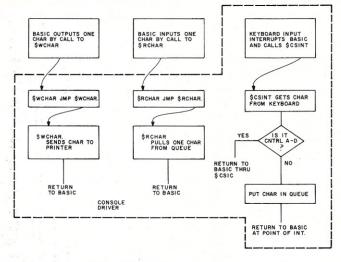


Fig. 1. Normal BASIC/Console Driver interaction.

Heath's software for sending and receiving characters to and from the video terminal or TTYtype I/O device. A source listing of it is conveniently provided in Heath's documentation.

Fig. 1 shows how the BASIC interpreter links with the Driver. Whenever BASIC outputs a character, it calls \$WCHAR, which contains a JMP instruction to \$WCHAR., the routine that actually sends the character to the I/O device. A similar process takes place for inputting a character: BASIC calls \$RCHAR, which jumps to \$RCHAR., the routine that pulls characters from a queue maintained by an interrupt-driven input program called \$SCINT.

\$SCINT processes console keyboard inputs and stuffs them in a first-in, first-out queue. It also monitors for special control-character inputs and, upon receipt of a CONTROL-A through CONTROL-D, will jump back to BASIC through the \$CSIC vector. These control characters will not be placed in the queue.

EDIT links with BASIC through the Console Driver as shown in Fig. 2. The jump addresses at \$WCHAR and \$RCHAR are changed to EDIT's OUTCHR and INCHR entry points so that EDIT gets a chance to look at the text sent from BASIC and modify the text sent to BASIC.

EDIT also calls \$WCHAR, and \$RCHAR, as required. The \$CSINT routine is also modified to make it jump to EDIT's CONC

routine where a CONTROL-C check is made. If one is typed, EDIT will terminate and CONC will return through the \$CSIC vector so that BASIC will also process the control character.

EDIT's OUTCHR and INCHR routines form the two main modules of the EDIT program. OUTCHR gets involved first. Its primary function is to save, on a line-by-line basis, the characters being output by BASIC. A 132-character buffer in this routine always contains the last full line of text that was output. The buffer starts at BUFST, and the present character position in it is pointed to by PNTR. PNTR is set to zero at each carriage return output by BASIC. It will not start moving from zero until a decimal digit is output.

Therefore, if you issue the

command LIST 100 into BASIC, the buffer will end up with the line number (100) plus the line of text for that line number. The characters sent by BASIC would include carriage returns, line feeds and the prompt, all of which would be rejected since they occur when the pointer is at zero and is waiting for a decimal digit.

EDIT's INCHR routine is constantly monitoring what you are keying into BASIC. It is always in one of the following three modes.

- 1. Normal BASIC. The editor has not been called, and inputs are sent to BASIC directly.
- 2. Search Mode. The editor has been activated by an ESC character. The next input is a search character, and the editor will transmit the text in the buffer up to and including it.
- 3. Modify Mode. This mode automatically follows completion of a successful search and places you in direct communication with BASIC for text modification or addition. This mode can be exited by either another ESC-search sequence, a carriage return or a CONTROL-C.

Heath's BASIC performs command completion and dynamic error detection during input for illegal character combinations. As an example of command completion, if you type PR, BASIC will output the entire word PRINT to the I/O device. This complicates the edit program since the line buffer will contain the full word PRINT, but during the search mode only the PR part can be sent to BASIC.

EDIT handles this by having OUTCHR sense when the editor is in the search mode and advancing the character pointer for the line buffer whenever a character is output by BASIC. INCHR will not see the INT because after it scans the R and sends it to BASIC, OUTCHR will advance the pointer to the next character after the T.

This reflects the way you choose search characters for commands. If the command PRINT is to be changed, the search character must be the R (the last letter typed for the command). The cursor will advance to the end of the command, and a single back space can be used to delete the entire word.

Dynamic error correction in Heath's BASIC prevents your entering certain detectable invalid character combinations, such as a variable with two alphabetic characters. This presents no problem in the modify mode since you are talking directly to BASIC and must fix the error before BASIC will allow you to continue.

However, you may do something that appears valid at the time of entry but causes characters in a following search mode or line entry (due to a carriage return) to be invalid. OUTCHR performs a special test for the condition and will stop the

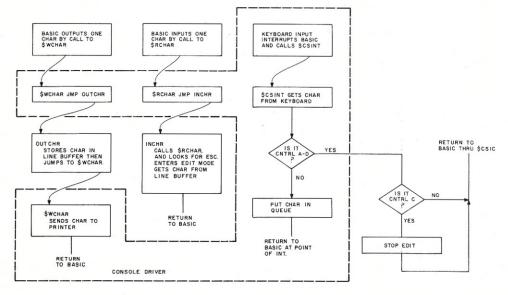


Fig. 2. BASIC/Console Driver/EDIT interaction.

```
************
                                         BASIC/EDIT
                                     *************
                                A LINE EDITING PROGRAM FOR HEATHKIT TAPE BASIC
                                3/25/79
                                 JAMES F. TEIXEIRA
                                 62 CHURCHILL ST
                                SUDBURY MA. 01776
                         SET HENTOP AS THE HIGHEST RAM LOCATION IN YOUR SYSTEM.
                         SET HIGH MEMORY IN BASIC TO BE 350 (DECIMAL) LOCATIONS
                         BELOW HIGHEST RAM.
                                           177377A * TOP OF 24K RAM SYSTEM
177.377
                       * FOR VERSION 10.05.00 DF EXT. BASIC. USE THE VALUES IN BRACKETS
040.332
                       SUCHAR.
                                           40332A
                                                     * BASIC'S WRITE ONE CHAR ROUTINE [40347A]
040.255
                       SRCHAR.
                                FOII
                                           402554
                                                       BASIC'S READ ONE CHAR ROUTINE [40302A]
                                           40252A
                                                       BASIC'S CONTROL REGISTER FLAGS [40214A]
040.252
                       $CSLCTL
                                FRU
040.250
                       $CSIC
                                                       RETURN ADD FOR CNTRL-A THRU -E [40212A]
176.207
                                ORG
                                           HENTOP-376
                        INIT SETS UP EDIT ENTRY VECTORS IN THE CONSOLE DRIVER.
                         INIT IS USED ONLY FOR THE FIRST COLD START INTO BASIC.
                       * IT MAY BE DESTROYED BY THE USER PROGRAM.
176.207
        041 004 177
                                           H. INCHR
                                                       SET UP INCHR JUMP VECTOR
                       INIT
                                LXI
176.212
         042 145 040
                                SHLD
                                           40145A
                                                        [40107A]
176.215
         041 241 176
                                IXI
                                           H, OUTCHR
                                                       SAME FOR DUTCHR
176.220
         042 150 040
                                SHLD
                                           40150A
                                                       [40112A]
176.223
         041 146 177
                                                        SAME FOR CHTRL-C TEST
                                LXI
                                           H.CONC
176.226
         042 141 041
                                SHLD
                                           41141A
                                                       [41315A]
                                           A,303A
                                                       CNTRL-C TO BE JUMP INSTRUCTION
176.231
         076 303
                                HUT
         062 140 041
                                           41140A
                                                       [41314A]
176.233
                                STA
176.236
        303 100 040
                                           40100A
                                                       ENTER BASIC
                         OUTCHR SAVES THE LAST LINE OF TEXT DISPLAYED IN BUFST INDEXED
                         BY PNTR. IT ALSO ADVANCES PNTR DURING THE SEARCH MODE IN EDIT
                         TO ALLOW SEARCHING THRU COMMAND COMPLETION. INVALID ENTRY
                         DURING THE SEARCH MODE CAUSES EDIT TO STOP AT THE INVALID CHAR.
176.241 345
                                PUSH
                                                     * SAVE REGISTERS
176.242
176.243
         325
                                PHSH
                                           PSW
176.244
         365
                                PUSH
176.245
         127
                                                       SAVE OUTPUT CHAR IN D
176.246
         315 260 176
                                           OUTCHR1
                                                       SAVE LINE ROUTINE
                                CALL
176.251
         361
                                PDP
                                           PSW
                                                       RESTORE REGISTERS
176.252
         321
                                POP
176.253
         301
176.254
         341
                                POP
                                                     * RETURN TO BASIC
176.255
         303 332 040
                                JMP
                                           SUCHAR.
176.260 072 166 177 OUTCHR1
                                LDA
                                           EDFLG
                                                     * SEE IF IN EDIT MODE
176.263
         247
                                ANA
                                                       SET FLAGS
176.264
         312 315 176
                                 JΖ
                                           DUTCHR2
                                                       NO, SAVE OUTPUT IN BUFFER
                                                       IN HODIFY HODE, RETURN
176.267
         370
176.270
         172
                                HOV
                                           A.D
                                                       MUST BE IN SEARCH MODE
SEE IF 'BEL' WAS OUTPUTTED
176.271
         376 007
                                CPI
176.273
         302 353 176
                                           DUTCHR4
                                                        NO, SEE IF BACKSPACE
176.276
         315 371 176
                                CALL
                                           BUFADD
                                                       SEE IF 'BEL' WAS SENT
                                                       GET LAST CHAR IN BUFFER
176.301
         176
                                MOU
                                           A,H
176.302
         376 007
                                CPI
                                                       WAS IT 'BEL
                                           INCPTR
176.304
         312 356 176
                                                        YES. TREAT AS NORMAL
176.307
         076 200
                                HVI
                                                     * ERROR DURING SEARCH, STOP IT
                                           A.200Q
         062 166 177
176.311
                                STA
                                           FDFI G
176.314
                                RET
176.315
         072 167 177
                     OUTCHR2
                                           PNTR
                                                     * TEST PHTR FOR ZERO
176.320
         247
                                                       SET FLAGS
         302 333 176
                                           OUTCHR3
                                                       PNTR NOT ZERO, PROCESS NORMAL
176.321
                                JNZ
                                                       PNTR AT ZERD, NEED DIGIT TO START
176.324
         172
                                HOV
176.325
         376 060
                                CPI
                                           600
                                                        600 = DIG O IN ASCII
176.327
         330
                                RC
                                                       DUT OF BIGIT RANGE
176.330
         376 072
                                           720
                                                       710 = DIG 9 IN ASCII
                                CPI
176.332
                                                       OUT OF DIGIT RANGE
         320
                                                       GET CHAR ADDRESS IN BUFFER
STORE IT IN BUFFER
176.333
         315 371 176 OUTCHR3
                                CALL
                                           RIIFANN
176.336
         162
                                YOK
176.337
         315 356 176
                                CALL
                                           INCPTR
                                                       HOVE POINTER TO NEXT POSITION
176.342
         172
                                YON
                                           A.D
                                                       GET CHAR
176.343
         376 015
                                CPI
                                           150
                                                       WAS IT CRY
176.345
         300
                                RNZ
                                                       NO. RETURN
176.346
         257
                                                       YES, SET PNTR TO 0 FOR NEXT LINE
174.347
         062 167 177
                                STA
                                           PNTR
176.352
         311
                                RET
176.353
         376 010
                       OUTCHR4
                                           100
176.355
        310
                                RZ
                                                     * YES, RETURN, ELSE INC. PNTR
```

search or line-completion entry at the point of error and will return EDIT back to the modify mode. If it is too late to correct the error, it's best to hit CONTROL-C to terminate EDIT and try again from the LIST step.

The program listing occupies 216 bytes plus an additional 132 bytes for the line buffer. The program consists of the modules INIT, INCHR, OUTCHR, CONC and two subroutines. INCPTR and BUFADD, RCHAR and WCHAR have been described above. INIT links EDIT with BASIC during the first cold start into BASIC by modifying the iump addresses in the Console Driver. CONC is a special routine used to process CONTROL characters and terminate EDIT on a CONTROL-C input. The two subroutines manipulate the buffer pointer and form addresses in the buffer for the next character to go in or come out.

Locating the Editor

The easiest place to locate EDIT is in the topmost part of RAM since BASIC can be configured from the distribution tape to avoid using this area. The program listing shows the program ORGed at the top of a 24K RAM system. This can be changed to any RAM limit by specifying MEMTOP as the address of the highest RAM location available (177377 for 24K, 137377 for 16K, etc.). EDIT is set up so that the line buffer occupies the top 132 RAM locations. This allows you to execute a RESET without harming the editor. The stack pointer, which is set to the top of RAM by RESET, will fall into the buffer area and not the program area.

Loading BASIC/EDIT

The first step in getting BASIC/EDIT into your system is easy. Starting with the Heath distribution tape for BASIC, set up your configuration parameters and include setting HIGH MEMORY to 350 (decimal) locations below the default limit displayed (for example, HIGH MEMORY = 32767/32417 for a 24K system). Execute the SAVE command to generate a configured BASIC tape.

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Program listing.

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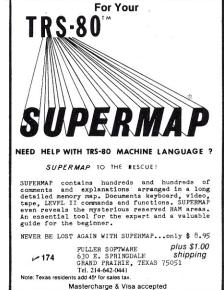
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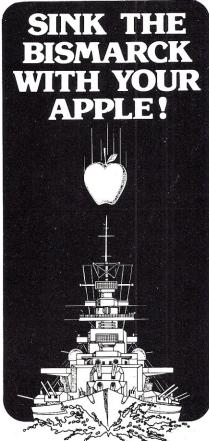
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* THE FOLLOWING ROUTINE INCREMENTS PATR
176.356 072 167 177 INCPTR
                                                      * GET POINTER IN A
                                LDA
                                           PNTR
176.361
         074
                                 INR
                                                      * INCREMENT IT
                                                      * MAX. 132 CHAR ALLOWED
* TRIED TO EXCEED IT
176.362
         376 204
                                 CPT
                                           2040
176.364
         310
                                 R7
176.365 062 167 177 INCPT1
                                           PNTR
                                                      * PUT IT BACK
                                STA
176.370 311
                         THE FOLLOWING ROUTINE FORMS THE ADD. OF THE CURRENT CHAR IN
                         THE BUFFER BY ADDING PNTR TO BUFST
176.371 072 167 177 BUFADD
                                LDA
                                           PNTR
                                                      * GET POINTER IN A
176.374
                                                      * FORM POINTER IN B.C.
         117
                                 MOV
                                           C.A
         006 000
                                           B. 0
176.375
                                 HUI
176.377
                                           H, BUFST
                                                      * START OF BUFFER
         041 170 177
                                 LXI
                                                      * ADD POINTER TO RUFFER START
177.002
         011
                                 DAB
177.003
        311
                                RET
                         THE FOLLOWING ROUTINE LOOKS FOR AN 'ESC' CHAR TO START THE EDIT
                         FUNCTION. FOLLOWING AN 'ESC' IT EXPECTS A SEARCH CHAR. AND WILL
                         OUTPUT THE LINE IN THE BUFFER UP TO THIS CHAR. THE USER CAN THEN
                         ADD OR DELETE TEXT OR ADVANCE THE LINE OF TEXT VIA ANOTHER 'ESC'-
                         SEARCH CHAR. SEQUENCE. A 'CR' WILL CAUSE THE REST OF THE LINE TO
                         BE SENT TO BASIC.
                                                      * SEE WHAT PRESENT MODE IS,
177.004 072 166 177 INCHR
                                           EDFLG
                                                        O=NORMAL. 200Q=HODIFY
                                                        1770=SEARCH END PENDING
                                                        ANYTHING ELSE=SEARCH MODE
177.007
         247
                                 ANA
                                                        SET FLAGS
177.010
         302 033 177
                                 JNZ
                                           TNCHRI
                                                        IN FRIT MODE
                                                        NOT IN EDIT. GET INPUT
177.013
         315 255 040
                                 CALL
                                           SRCHAR.
                                                        IS IT ESC?
177.016
                                 CPI
                                           330
         376 033
177.020
                                                        NO. RETURN
                                                      * YES, POINTER MUST BE AT ZERO FOR EDIT
177.021
         072 167 177
                                 INA
                                           PNTR
177.024
         247
                                 ANA
177.025
                                           INCHR3
         312 075 177
                                 JZ
                                                      * OK. IT'S AT ZERO
177.030
         076 033
                                 HUT
                                           A,33Q
                                                      * NOT AT ZERO, RETURN WITH ESC IN A
177.032
         311
                                 RET
         376 177
                                 CPI
                                           1770
                                                      * IS IT SEARCH END PENDING
                       TNCHR1
177.033
                                                      * NO, IN SEARCH HODE
                                           INCHR5
177.035
         332 103 177
177.040
         302 057 177
                                 JNZ
                                           INCHR2
                                                      * NO, IN HODIFY HODE
                                                      * SEARCH MODE WAS PENDING
177.043
         072 167 177
                                 LDA
                                           PNTR
177.046
         075
                                 DCR
                                                      * DECREMENT PHTR
177.047
         062 167 177
                                           PNTR
                                 STA
                                                      * AND SET TO MODIFY MODE
177.052
         074 200
                                 MUT
                                           A,2000
177.054
         062 166 177
                                 STA
                                           EDFLG
177.057
         315 255 040
                       INCHR2
                                            $RCHAR.
                                                      * IN HODIFY MODE. GET CHAR
177.062
         376 033
                                 CPI
                                           330
                                                        IS IT ESC!
                                                        YES, START NEW SEARCH
IS IT CR?
                                           INCHR3
177.064
         312 075 177
                                 JZ
177.067
         376 015
                                 CPI
                                           150
177.071
                                           INCHR4
                                                        YES, EDIT COMPLETE
         312 100 177
177.074
         311
                                 RET
                                                        TREAT AS HODIFY INPUT
                                           $RCHAR
177.075
         315 255 040
                      INCHR3
                                                        GET INPUT, ITS A SEARCH CHAR
                                 CALL
177.100
         062 166 177
                       INCHR4
                                                      * SAVE IT
                                           EDFLG
                                 STA
177.103
177.104
         305
                                 PIISH
                                                      * FORM BUFFER ADDRESS
         315 371 176
                                           BUFADD
177.105
                                 CALL
177.110
         176
                                                        GET CHAR FROM BUFFER
                                 MOV
                                           A.H
177.111
         117
                                                        SAVE IT IN C
                                 MOU
177.112
         376 015
                                 CPI
                                           150
                                                        WAS IT A CR?
177.114
         302 123 177
                                 JNZ
                                           INCHR6
                                                        NOT CR
                                                        YES, CLEAR EDIT MODE
177.117
         257
                                 XRA
177.120
         303 137 177
                                 JMP
                                           INCHR7
177.123
         072 166 177
                       INCHR6
                                 LDA
                                           EDFLG
                                                      * GET SEARCH CHAR
                                                        IS IT SAME AS IN BUFFER
177.126
         271
                                 CMP
177.127
         302 142 177
                                            INCHRS
177.132
         315 356 176
                                 CALL
                                           INCPTR
                                                      * CHAR FOUND. INC. POINTER
                                           A-1770
                                                      * FLAG END OF SEARCH PENDING
177.135
         076 177
                                 TUM
                                           EDFLG
         062 166 177
                       INCHR7
177.137
                                 STA
177.142
                                                      * GET CHAR
                       INCHR8
                                 HOV
                                           A,C
177.143
         301
                                 POP
                                 POP
177.144
         341
177.145
                         TEST FOR CONTROL C. HEANS LEAVE EDIT HODE WITHOUT ALTERING LINE
                                                        CONTROL CHAR FLAG BITS
177.146 072 252 040
                       CONC
                                            $CSLCTL
177.151
         346 040
                                 ANI
                                            400
                                                        CONTROL C FLAG
                                           CONCI
177.153
         312 162 177
                                 JZ
                                                        NOT CONTROL C
177.156
                                 XRA
                                                        CLEAR EDIT HODE
         257
                                           EDFLG
177.157
         062 166 177
177.162
         052 250 040
                       CONCI
                                 LHLD
                                           $CSIC
                                                      * JUMP TO NORMAL CONTROL PROCESSING
177.165
         351
                                 PCHL
                         STORAGE LOCATIONS
                                                      * FLAG REGISTER FOR PRESENT MODE
177.166
                       EDFLG
177.167
         000
                       PNTR
                                 DB
                                           0
                                                      * POINTER FOR LINE BUFFER
                                                      * START OF LINE BUFFER, EXTENDS TO MEMTOP
                       BUFST
177.170
         000
                                 DB
                                                      * SETS PROG. TO START AT INIT
                                 END
                                           INIT
177.171
```

since you must now generate a tape of the EDIT program shown in the program listing. It can be hand keyed in from the listing directly for a 24K RAM system or hand modified or reassembled to fit your memory size. Once in memory, a tape can be generated using the DUMP button on the H8. Set the Program Counter to the INIT address before dumping the tape so that EDIT will automatically start there.

These two programs form BASIC/EDIT. They can both be on the same tape with BASIC first, followed immediately by EDIT. To use them, first load the BASIC part into your system. Don't press GO. Then load in the EDIT portion. Now press GO, and the INIT routine will set up the Console Driver to link with EDIT and will then jump to the normal BASIC cold-start address.

BASIC/EDIT can now be used in exactly the same way as normal BASIC except it will respond to the edit commands. Your programs can be loaded, dumped, run or edited. Note that the configured BASIC tape can be used by itself by pressing GO immediately after loading it. The editor part only has to be loaded if you foresee a need to do line editing.

Conclusion

EDIT can be entered only if the first ESC is done when the cursor is at the beginning of the line (at the prompt character). This prevents accidental entry into EDIT in the middle of a manual entry. Don't forget that a CONTROL-C can be used at any time in the edit process to recover from a botched-up edit sequence. Finally, multiple ESCsearch entries can be made to position the cursor at the desired place in the line if you want to stop at a point that is not at the first occurrence of the character.

I am sure you will enjoy using BASIC/EDIT and will wonder why Heathkit didn't provide it as part of their BASIC. I find it so useful that I am presently modifying it to work with Heath's Text Editor (TED-8), which does not have this type of characteroriented editing capability.

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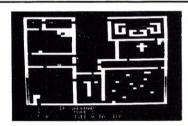
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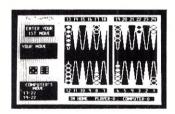
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Calculating Interest Rates

The way interest rates wildly fluctuate, who can even remember what they are from day to day? You can—by using this North Star interest-rate-calculation program to keep track.

John A. Bryant 6648 N. Canandaigua Rd. Holcomb, NY 14469

ost people can recall the principal amount and term of their loans, as well as the monthly payment, but few can remember the interest rate. Strangely, almost all amortization schedule programs require the input of the interest rate in order to run the program, although most programs will calculate the monthly payment if necessary. This means that if you don't know the interest rate you can't run the program.

Introduction

Recently I needed to determine the interest rate of a particular loan, so I decided to add a few lines to my amortization schedule program to calculate it when it is unknown. After all, you can simply rearrange the equation that calculates the monthly payment so that it is solved for the interest rate instead of the payment . . . or so I thought!

I listed my amortization schedule program and found the equation to be: $M = P^*(R^*(1$ $+ R)\uparrow N)/(((1 + R)\uparrow N) - 1)$, where

M = monthly payment

P = principal

R = monthly interest rate

N = number of months in

finding the interest rate in precisely that manner, and I have adapted and expanded it into a form that should run with about any BASIC.

The only part of the program not strictly standard is line 360: A\$ = A\$(1,1). If your BASIC does not recognize the convention

the case may require, calculate again and then again compare the result to the monthly payment. This procedure is repeated until the two figures are the same (to the nearest penny), at which time the program prints the interest rate.

The program is not set up to calculate interest rates of over 100 percent. Where the interest rate equals or exceeds 100 percent, a message to that effect will be printed. (For those of you involved with loan sharks, simple changes in lines 190, 270 and 280 will permit calculation of interest rates over 100 percent.) Similarly, if the monthly payment is not sufficient to amortize the loan even at no interest, a message to that effect will be printed.

The program can be kept as a separate program as written and loaded and run as needed, or you may add it as a subroutine to your amortization schedule program so it will always be ready when you need it. Assume your amortization schedule program uses R as the variable for the interest rate. To add the program as a subroutine, delete lines 350 through 390, change line 340 to RETURN, modify the

XXX INPUT "ANNUAL INTEREST RATE (ENTER 0 TO CALCULATE)? ";R XYX IF R=0 THEN GOSUB YYY

Example 1.

Seventeen sheets of paper later, I concluded I couldn't solve the equation for R, so I started looking for a book or article in which someone smarter than I had done the work for me.

I found an article in the April 1979 issue of Memory Pages, the monthly magazine of the Rochester Area Microcomputer Society. The author, Reid Shay, stated that there is no equation to calculate interest rates!

Apparently the only way to calculate interest rates is by trial and error-just what computers do best. Mr. Shay had a short program in his article for

utilized in line 360, simply leave that line out. Those who have the LEFT\$ function can rewrite the line as A\$ = LEFT\$(A\$,1).

How the Program Works

My program in North Star BASIC uses the formula from my amortization schedule program and calculates a monthly payment using 50 percent as its first guess for the interest rate. It then compares the monthly payment so calculated to the monthly payment being made on the loan. If they are not the same, it will adjust the interest rate upward or downward, as

INTEREST RATE CALCULATION PRINCIPAL? MONTHLY PAYMENT? 275.35 HOW MANY YEARS (TYPE 0 TO ENTER MONTHS)? 30 INTEREST RATE IS 8.75% WANT TO DO ANOTHER (Y/N)? YES PRINCIPAL? 1000 MONTHLY PAYMENT? 150.00 HOW MANY YEARS (TYPE 0 TO ENTER MONTHS)? 0 HOW MANY MONTHS? 6 PAYMENT SET TOO LOW FOR A 6 MONTH LOAN PRINCIPAL? 1000 MONTHLY PAYMENT? 1000 150.00 HOW MANY YEARS (TYPE 0 TO ENTER MONTHS)? 0 HOW MANY MONTHS? 7 INTEREST RATE IS 14.82% WANT TO DO ANOTHER (Y/N)? Y PRINCIPAL? 1000 MONTHLY PAYMENT? 175.00 HOW MANY YEARS (TYPE 0 TO ENTER MONTHS)? 1 INTEREST RATE IS OVER 100% PRINCIPAL? 32500 MONTHLY PAYMENT? 357.86 HOW MANY YEARS (TYPE 0 TO ENTER MONTHS)? 20 WANT TO DO ANOTHER (Y/N)? NO THANKS Sample run.

input portion of the amortization schedule program as shown in Example 1 and alter the line numbers. To keep it simple you might alter the line numbers by adding 1000 or 2000 to each.

Unless you know the interest rate, you can't run most amortization programs. Thus, if you have an amortization program, you should add this short and simple program to your tape or disk for those times, certain to occur, when you don't know the interest rate of a particular loan.

```
PPM***************************
       ***
REM** THIS PROGRAM CALCULATES THE INTEREST RATE WHERE THE **
REM** PRINCIPAL, MONTHLY PAYMENT, AND TERM OF LOAN ARE **
                     PRINCIPAL, MONTHLY PAYMENT, AND TERM OF LOAN ARE
       REM**
REM**
                                                        KNOWN.
       PRINT TAB(10); "INTEREST RATE CALCULATION"
PRINT
PRINT
100
110
100 PRINT
110 INPUT "PRINCIPAL? "; P
120 INPUT "MONTHLY PAYMENT? "; M
130 INPUT "HOW MANY YEARS (TYPE 0 TO ENTER MONTHS)? "; N
140 IF N>0 THEN N=N*12
150 IF N=0 THEN INPUT "HOW MANY MONTHS? "; N
160 PRINT
170 IF N*M<P THEN PRINT "PAYMENT SET TOO LOW FOR A"; N; " MONTH LOAN"
180 IF N*M<P THEN 90
190 H=100
200 L=0
210 R=(H+L)/2
210 T=R/1200
220 T=R/1200
230 M1=P*(T*(1+T)AN)/(((1+T)AN)-1)
240 IF M+.01>M1 THEN 300
250 IF M1<M THEN L=R
260 IF M1>M THEN H=R
270 IF R=100 THEN PRINT "INTEREST RATE IS OVER 100%"
280 IF R=100 THEN 90
280 IF R=100 THEN 90
290 GOTO 210
300 IF M-.01<M1 THEN 320
310 GOTO 250
320 R=INT(R*100+.5)/100
330 PRINT "INTEREST RATE IS";R;"%"
340 PRINT
350 INPUT "WANT TO DO ANOTHER (Y/N)? "; A$
360 A$=A$(1,1)
370 IF A$="Y" THEN 90
380 IF A$<>"N" THEN 350
390 END
                                                   Program listing.
```







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Add Handshaking to Apple's High Speed Interface

This modification to the Apple Serial Card allows it to handshake properly with other devices such as printers. The mod is unique because it does not require a software patch.

Jeffrey G. Mazur 8041 Sadring Ave. Canoga Park, CA 91304

y now, most people who Bown an Apple High Speed Serial Interface are aware of its

lack of handshaking capabilities. Several modifications have appeared (one directly from Apple), but these involve using the data input line as a CTS (clear to send) or DTR (data terminal ready) in-

A major problem—aside from

giving up duplex operationwith this approach is that it requires a software patch. This means that every time the serial card is to be used, a patch program must be loaded from cassette or disk. Also, the patch restricts the card to one particular slot. And if that isn't enough, try loading the patch from Apple

These problems defeat the purpose of having "intelligent interfaces" with complete software in PROM. Fortunately, there is a simple modification that can be added to perform the handshaking without any software patches.

The schematic for the modification is shown in Fig. 1. Note that no direct connection to the serial card is required; thus, the entire modification could be done on a prototyping board and plugged into any slot on the Apple II. This would avoid warranty problems incurred with making changes to the serial card itself.

However, the low parts count (two, with TTL handshaking) of this circuit makes it feasible to mount everything and make all connections directly on the serial card. This is the preferred method, since it doesn't take up another slot and saves the price of the protoboard.

Theory

This simple handshaking circuit makes use of the RDY (ready) signal on the 6502 and

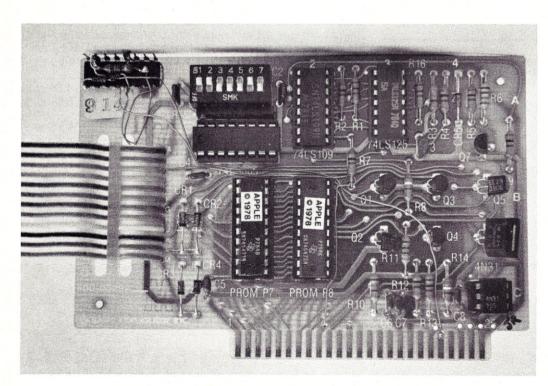


Photo 1. Serial Card with modification on component side. Note all parts mount directly on IC.

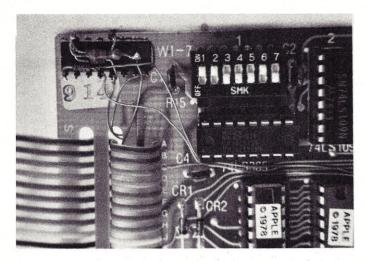


Photo 2. Close-up of added parts.

Apple bus. This signal is normally high (via a pull-up resistor); when pulled low it causes the 6502 to enter a wait state. The computer will do nothing until the RDY line goes high again.

This is exactly what we want the computer to do when a printer or other serial device signals (via a low CTS or DTR) that it is busy or cannot accept any more data into its buffer. If the 6502 did not restrict when the RDY line could change state this modification would consist simply of one diode! However, the specifications on the 6502 state that the RDY line should change from high to low or vice versa only during the Ø1 clock time (if it changes during Ø2 the CPU will hang up).

This is one of my pet peeves about the 6502: why didn't they include a latch on the chip to ensure this? Since they didn't, we must use one section of a

74LS75 quad data latch to restrict the RDY line to change only during 01. D1 is used to couple only the low state of the latch to the RDY line on the Apple bus. This is necessary to allow other peripheral boards to also use the RDY line (i.e., pull it low) without conflicting with the high state of IC1. Finally, R1, D2 and D3 are used (if necessary) to convert RS-232 levels to TTL levels.

Construction

If you want to use a separate protoboard, simply mount the parts and connect the CTS or DTR line from the printer to pin 2 of IC1 or R1. Mounting the modification on the serial board can be done in one of two ways.

A socket for IC1 can be added by drilling six holes in the upper left-hand corner of the board. All unused pins of the socket should be cut off. Then wire on the back

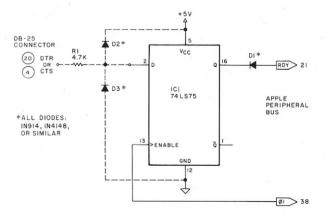


Fig. 1. Simple handshaking circuit for the Apple Serial Card. Marked components are used if handshaking signal uses RS-232 levels. If your device uses an active high busy signal, move D1 to IC1, pin 1.

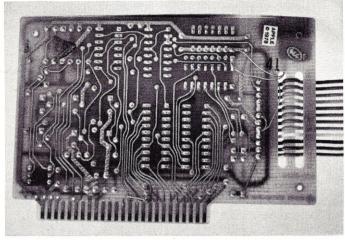


Photo 3. Back side of boards showing connections to ground, +5 V, DB-25 and pin 38 of edge connector (see Fig. 2).

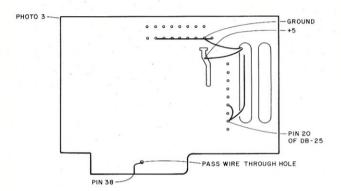


Fig. 2. Points in Photo 3.

side of the circuit board using small gauge (e.g., #30 wire-wrap) wire.

The other method involves mounting the parts on the component side. This method, which requires no drilling, is outlined below.

Refer to Photo 1 for the location of IC1 and carefully glue the chip upside down on the PC board. Make sure that the glue has dried securely before continuing with the wiring. Now carefully connect IC1 as neatly as possible to avoid shorts or bad connections.

When attaching wires to the IC pins, strip back only a small amount of insulation and then tin the pin and the wire with solder. Holding the wire vertically, lightly touch the iron to the IC pin and then quickly join the wire and remove the iron. Use similar care when attaching the other parts to IC1. Note that the ground connection can be made at the common trace of the DIP switches. The fat trace just below it is +5 V. If you have any doubts about your soldering capabilities, you can use insulating spaghetti or shrink tubing to further protect against shorts.

When wiring to the connector fingers, use the smallest amount of solder possible and make the connection at the top of the finger. Avoid getting any solder on the lower two-thirds of the finger (the part that goes into the computer).

Finally, to make connection to the DB-25 cable, determine which pin carries your printer's busy signal. If it uses a CTS signal, it will probably be on pin 4. Therefore, attach the wire from IC1, pin 2 (TTL), or R1 (RS-232) to hole D (yellow wire of the ribbon cable). If your printer uses a DTR signal (pin 20), connect to hole H (gray wire). Now check all your wiring and-for a professional job-use tiny drops of silicone sealer to secure the wires to the circuit board.

Testing and Operation

When you are sure that everything is correct, plug the serial



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HRZ-1-32K-Q	2300.	1750.	HAZELTINE 1510	1050.
HRZ-2-32K-Q	2700.	2230.	TELEVIDEO 912 TELEVIDEO 920	700. 750.
RAM-16K	365.	325.	TELEVIDEO 920	750.
RAM-32K	565.	515.	PRINTERS	
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MDS-A-D	710.	660.	TI-810	1580.
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board back into the computer. Connect your printer and go through the normal procedure to check it out. If the computer hangs up when you turn it on, check the polarity of the busy signal from the printer. Most devices use an active low signal (i.e., line is normally high: a low level signifies that the device is not ready to receive more data).

If your printer works in reverse, move D1 from IC1, pin 16, to pin 1. This picks up the inverted output from the latch.

If you have been running the printer at a slow baud rate to avoid overflow problems, check it out first at this slow rate. If it operates normally, change both the serial card and printer baud rates to the maximum, keeping them both the same. Now watch the printer zip away.

If your printer has an input buffer, the Apple will now send data to the buffer at a high baud rate (usually filling the buffer faster than the printhead can empty it). If the buffer becomes full, it will pull the RDY line low,

halting the computer while the printer catches up. At this point the computer will sync up, with the printer sending one character for each character the printhead prints (but not the same one). After the computer stops sending, the printer will continue to operate until it empties the buffer.

Conclusion

Since most of the newer, lowcost printers have input buffers. being able to handshake correctly is an important feature. Although the Apple Serial Card lacks this capability as supplied, there are simple ways to add this feature.

The modification I have presented here seems to be the best approach, since it does not involve any software patches. I have used the serial card in this manner for many months (even with Pascal) without any problems. With hard copy as relatively slow as it is, it's nice to know that the printer is working as fast as it can.

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Predict Variable Trends

Interpolation by microcomputer is a practical alternative.

here are many times when we have to predict the value of an unknown function F(X) or a variable such as voltage, current, capacitance, impedance, etc., for an arbitrary value of an independent variable X, based on a group of known interpolation points (Xi,F(Xi)), which are the result of a finite number of tests or measurements at those points.

Hence, it is possible to monitor, for instance, temperature, pressure or radiation trends as a function of time and to predict

their value using some kind of "predicting" algorithm. For example, this method might have been very useful at Three Mile Island on March 28, 1979!

Lagrange's Interpolation Formula enables approximate evaluation of any function, at an arbitrary point, based on a known group of interpolation points. Lagrange's formula allows us to predict the value of any physical, chemical or electrical parameter (which could be monitored by means of some kind of transducer, converted by an A/D

converter, and then processed by a microcomputer using our "predicting" algorithm), and perhaps prevent system failures before they can occur.

The program listing was written originally for an SWTP 6800 microcomputer with 16K of memory (9K occupied by BASIC Interpreter), which utilizes Lagrange's Interpolation Formula to predict the value of any input variable X. In this example, port 1 is assigned to terminal, while port 7 is assigned to printer.

The sample run was performed with five interpolation data points; abscissae were angles in degrees (0, 30, 45, 60, 90°). According to well-known values of sine function for those angles (0, 0.5, 0.707, 0.866, 1, respectively), the computer predicted almost the exact value of the variable (sine function in our case) for an arbitrary data point X (here, it is angle of 20 degrees). Note that the error rate was less than 10E(-5) or 0.001 percent.

User-defined and decoded control characters at lines 1 and

```
110 NEXT I
  PRINT CHR$(16); CHR$(22)
  DIM X(20);Y(20)
REM * CREATED BY BLAZIMIR P. MISE, EE *
                                                         112 PRINT
                                                         113 PRINT CHR$(16); CHR$(22)
8 REM * @ SWTP 6800 COMPUTING SYSTEM
                                                         114 PORT=
10 INPUT " NUMBER OF DATA POINTS ", N
                                                         115 PRINT
                                                                         LAGRANGE'S INTERPOLATION FORMULAE"
                                                         116 PRINT
                                                                         FOR N RANDOM DATA POINTS'
12 PRINT
            TO N
* DATA POINT # ";I
ABSCISSAE X(I)",Z: X(I)=Z
TAMA VALUE ",Z1: Y(I)=Z1
15 FOR I=1 TO N
                                                         117 PRINT
                                                                                      VERSION 1.0"
                                                         118 PRINT
20 PRINT "
   INPUT "
                                                                    " DATA POINT NO. ABSCISAE DATA VALUE"
                                                         120 PRINT
   INPUT "
                                                         122 PRINT
                                                         125 FOR I=1 TO N
   PRINT
35 NEXT I
                                                         127 PRINT TAB(5); I; TAB(20); X(I); TAB(30); Y(I)
40 INPUT "
                                                         130 NEXT I
            DESIRED DATA POINT X",X
                                                         132 PRINT
    S = \emptyset
50 FOR I=1 TO N
                                                         133 PRINT " DESIRED DATA POINT X= ";X
    P=1
                                                         134 PRINT
60 FOR J=1 TO N
                                                         135 PRINT
                                                                      POLYNOMIAL'S VALUE"
   IF J=1 THEN 100
65
                                                                      P(X) = "; S
                                                         137 PRINT
70
   A=X-X(J)
                                                         140 PRINT
                                                         142 PRINT "
75
    B=X(I)-X(J)
                                                                      CREATED BY BLAZIMIR P. MISE, EE"
                                                             PRINT " @ SWTP 6800 COMPUTING SYSTEM
80
    P=P*A/B
100 NEXT J
                                                         147 PORT= 1
     S=S+Y(I)*P
                                                         150 END
                                                 Program listing.
```

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LAGRANGE'S INTERPOLATION FORMULAE FOR N RANDOM DATA POINTS VERSION 1.0

DATA POINT NO. ABSCISAE DATA VALUE

1	Ø	Ø
2	30	0.5
3	45	0.707
4	60	Ø.866
5	90	1

DESIRED DATA POINT X= 20

POLYNOMIAL'S VALUE $P(X) = \emptyset.341999988$

CREATED BY BLAZIMIR P. MISE, EE @ SWTP 6800 COMPUTER SYSTEM

COMPARE RESULT WITH EXACT VALUE OF SINE FUNCTION :

0.341996

ERROR : 3.88E-06

Sample run.

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Use Your Exidy As a Smart Terminal

"Talk" to maxi-computers with the Exidy Sorcerer.

Ernest E. Bergmann Physics, Bldg. #16 Lehigh University Bethlehem, PA 18015

he Exidy Sorcerer, which costs about the same as a dumb computer terminal, can be used as a 300 baud dial-up terminal to a large computer (such as the DEC-20 at our college campus). I have developed software that successfully uses the Sorcerer's on-board RS-232compatible serial port. Not only can I talk to the large computer with my "terminal," but I can transfer larger data files (20K ASCII files, such as the assembly listing) between my computer and "big brother."

With the DEC-20's help, I can now print, edit, maintain and exchange large files with other computers for the cost of a modem. I wrote the manuscript for this article with the help of a large computer that has well-maintained software (editors and formatters) and hardware (disk storage and printers).

My hardware consists of the Exidy Sorcerer, two cassette recorders, one modified TV monitor, a modem and a telephone. The bare Sorcerer has quite a few facilities on-board,

including the necessary RS-232 hardware to connect to the modem. However, it took me a while to figure out how to use the serial interface because of limited documentation and what appears to be a sofware bug in the monitor.

The Exidy's UART function can be selected in software to communicate either with the cassette recorders or through the RS-232 interface. The choice is controlled by bit 7, the most significant bit of port FE (hex). For operation of the RS-232 interface this bit must always be set (on). Whenever this bit is reset (off), the cassette interface has the UART's attention and, unfortunately for this application, the RS-232 output then has a space signal (the opposite signal, a mark, must be used instead between transmitted characters).

This same output port FE is also used to control the baud rate with bit 6 (on for 1200 baud and off for 300 baud). The motors for cassette #1 and #2 are controlled by bits 4 and 5; the remaining output bits of port FE, 0 through 3, are used to scan the keyboard. The monitor's keyboard scan routine, which normally sees heavy use, needs to constantly change these four,

lowest-order bits of port FE. Inadvertently, this keyboard routine is always resetting bits 5 through 7, rendering the RS-232 unusable.

To correct this software bug in the monitor ROM, I hit upon the following solution: copy the keyboard scan routine in its entirety into RAM but modify the few places where the offending bits are produced. In this way, I wrote the subroutine KEYBD2 (more suited to my application), which appears in the program listing, lines 40 through 179. Line 46 differs from the original keyboard scan routine, which had "LD A,1"; I changed line 64 in a similar way.

There is a second keyboard routine in the monitor, QCKCHK, which quickly checks to see if a control-C, Escape or RUN/STOP is pressed. It, too, must use the output port FE, but it can leave the most significant bits in the state specified by bytes located at IY + 45H and IY + 3DH in memory. Thus, QCKCHK does not need to be replaced; changing these two bytes is simpler, see lines 225 and 226.

Full-Duplex Operation

Full-duplex means that our keyboard's output is sent to the modem and, simultaneously, the modem's received signal must be displayed on the TV monitor. This simultaneous I/O means we must be always listening to both the modem and the keyboard and talking to both the CRT and the modem. This may seem easy to do with an interrupt-driven computer, but the Sorcerer's on-board hardware does not seem designed that way.

We may envision the problem as two separate processes:

- 1. If a key is pressed, send its value out the RS-232.
- 2. If a character is received from the modem, place it on the

Of the two, the second process is faster and is the basis of the routine INPIFR, "input if ready." This subroutine (starting at line 180) checks the UART status, and if a character has been received, it transfers control to SHOW (line 186), which puts the character on the screen. Placing INPIFR at the end of KEYBD2 and CALL IN-PIFR elsewhere in the program appears to catch all of the input character stream without interfering with process 1 which can now be thought of as:

1. When a key is pressed, send its value out the RS-232.

The top level of my program is TERMNL (lines 223 to 232); it is the embodiment of the modified process 1. It calls KEYBD2 until a character is typed. SEROUT (the RS-232 output driver) is called when a character is eventually typed. If line 230 and all lines beyond 232 were removed, then you would have a complete, full-duplex, dumb terminal.

Adding SMARTS

I still needed to develop more versatile software that would take advantage of the Sorcerer's programmable intelligence. I have implemented four principal objectives:

- 1. To send a large ASCII file from the Sorcerer's memory to the computing center.
- 2. To receive a large ASCII file from the computing center and place it in my RAM.
- 3. To view the contents of RAM. 4. To exit to the monitor to do local chores such as load from or save to cassette.
- I figured that I would never need to send graphic characters (here the Exidy sets the most significant bit to one) to the computer center; in fact, the central computer ignores the parity bit. Therefore, I could filter out such characters (using lines 229 and 230) before sending them to SEROUT.

I arbitrarily chose the graphicshift-period combination, 0EFH, as a special-graphics character to signify that I desired one of the four special functions. Any other graphic character is ignored (lines 234 and 235). When this special character is typed, a prompt, <<< appears on the screen, indicating that it is ready for one of the four types of requests.

Rather than writing my own routines to fill a line buffer with the request and then routines to interpret it, I was able to make use of routines already present in the monitor's ROM. The monitor's input routine, MIN-PUT, normally makes use of the keyboard scan routine that contains the software bug we need to avoid, so I patched the input with KEYBD2 at memory locations IY+41H and IY+42H (lines 236 to 239).

Starting with line 244, I used MINPUT, set HL to the beginning of the line buffer and called FTOKEN, which will return with the Z-flag set if the line is empty; otherwise, register A will contain the first non-blank character in the line, which should be S, R, V or X for the four possible commands. If none of these four characters is found, the program will display questions marks and ignore the request (QQ, starting at line 257).

Sending Files

Before I tell you about the software for sending files, I will describe its use. Suppose I need to send several kilobytes of text that is sitting in the Sorcerer's RAM starting at location 1000H. Assuming that the central computer is ready to receive it, I type the special-graphics character (which produces the prompt) and then S, <space>, 1000 and <CR>.

The "terminal" will start sending the contents of RAM until either a key that QCKCHK can detect is pressed or the end-offile is reached. When the "terminal" stops sending, it will display the address in memory of the byte beyond the last one sent. (So I can easily resume sending where I left off or can estimate the length of the file just sent.) The end-of-file character that I use in RAM, MEOF, is defined in line 34.

Writing a suitable routine is challenging because of the inability of the large computer to keep up with a long, continuous, input stream. Undoubtedly, each computer system is likely to react differently.

The TOPS-20 operating system of the DEC-20 computer reacts in the following way: initially it accepts input, gradually falling behind in the echoed signal (sending back what it receives so that it is visible on my TV monitor). After it has fallen behind about three lines (100 to 200 characters), it sends out a control-S, which is supposed to mean that I should pause in my transmission while the DEC-20 catches up by processing its input buffer. A little later, it sends a control-Q to indicate that it is OK for my com-

			Pron	ram lis	tina	
ADDR	OBJECT	ST	riog	nani iisi	ing.	
		0001	,			
		0003	FULL DU			R THE EXIDY
>E1A2			GETIY	EQU	nann, Jar OE1A2H	MONITOR ADDRESS OF
		0006 0007				FROUTINE THAT PLACES
>EOOC		0008	SEND	EQU	OEOOCH	;LOCATION IN IY ;MONITOR ROUTINE THAT
		0010				SENDS TO CURRENT OUT-
>0060		0012	LSTKEY #START 0	EQU F TABLE	ACH LOCATION	FUR
>EC1E >EC6E		0014	INSTBL GRATBL	EQU	OEC1EH OEC6EH	#INSTRUCTIONS #GRAPHICS
>ECBE		0016	CONTBL	EQU	OECBEH	FCONTROL.
>ED0E >ED5E		0017 0018	SLOTEL	EQU	OEDSEH	\$SHIFT \$SHIFT-LOCK
>EDAE >000D		0019 0020		EGU EGU	OEDAEH	\$UNSHIFT
>000A		0021 0022	******			******
>00FF		0023 0024	VDLY	EQU	OFFH SMA	RTS: ;VIEW DISP RATE
>E015 >E205		0025 0026	CRLF	EQU	0E015H 0E205H	
>E13A >E1BA		0027	MINFUT	EQU	OE13AH OE1BAH	
>E225 >E1E8		0029	FTOKEN MUNCNV	EQU EQU	0E225H 0E1E8H	
>E22F >E23D		0031	GTOKN2	EQU EQU	0E22FH 0E23DH	W. The state of th
>FF01		0033	OUTDLY	EQU	OFF01H	DELAY FOR BSOUT
>0000 >001A			MEOF CCEOF	EQU EQU	00 01AH	FEOF IN RAM FEOF USED BY
		0036	******			COMP CENTER ***********
10000	C35601′	0038	DUPLEX	GLOBAL JP	DUPLEX TERMNL	
0003 0005	FDE5 CDA2E1	0041	KEYBD2	CALL	GETIY	
10008	C5 D5	0042		PUSH PUSH	BC DE	
'000A	E5 DDE5	0044		PUSH	HL IX	
1000D	3E81 D3FE	0046		LD OUT	A,81H (OFEH),A	
0011	DBFE CB4F	0048		IN BIT	A, (OFEH)	
10015	200E 018813	0050		JR LD	NZ NORPT	-\$
'001A	OB	0052	REPET	DEC	BC	
'001B	78 B1	0053		LD OR	A,B	
001D	20FB FD7E6C	0055 0056		JR LD	NZ,REPE A,(IY+6	
10022	C3F700′ AF	0057 0058	NORPT	JP XOR	FINEND A	==
10026	OEFE 5F	0059		L.D L.D	C,OFEH E,A	
'0029 '002B	CBFB 1600	0061		SET LD	7,E D,0	
'002D	42 2680	0063		L.D L.D	B,D H,80H	
10030	DD211EEC ED61	0065		LD OUT	IX, INST	BL
0036 0038	2E01 ED78	0067		LD	L,1 A,(C)	
'003A	A5 C2C900'	0069		AND JP	L NZ,ABIT	1
'003E	E5 210001	0071		PUSH	HL	
1003F 10042	2D 20FD	0073		DEC	HL,100H L NZ,DEBO	IN- \$
0043 0045	25	0074		JR DEC	H	
10046	20FA E1	0076		JR POP	NZ, DEBO	JN-\$
10049 1004B	ED78 A5	0078		AND	A, (C) L	
1004E 1004F	DD5600	0080		JP LD	NZ,ABIT	
10052 10054	CB7A 281A	0082		BIT JR	Z,CODED	- \$ "
10056 10058	CB62 2802	0084		BIT JR	4,D Z,NONGR	A-\$
1005A 1005C	CBF0 CB5A	0086	NONGRA	BIT	6 - B 3 - D	
1005E 10060	2802 CBE8	0088		JR SET	Z, NONCO	N-\$
10062	CB52 2802		иоисои	BIT	2,D Z,NONSH	T-\$
9900,	CBEO CB4A	0092	NONSHI	SET	4,B 1,D	
'006A	285D	0094		JR	Z,ABIT1	\$
7006C	CBD8 1859	0095		SET JR	3,B ABIT1-\$	
10070	E5 D5	0097		PUSH	HL DE	
10072	DDE5 E1	0100		POP	HL HL	
10075 10078	111EEC B7	0101		LD OR	DE, INST	BL
10079	ED52	0103		SBC WHICH T	ABLE TO	JSE
'007B	D1 CB70	0105		POP BIT	DE 6.B	
1007E	2815 CB72	0107		JR BIT	Z,NOGRAI	P\$
10082	2811 D5	0108		JR PUSH	Z, NOGRAF DE	>-\$
10085	116EEC 19	0111		LD ADD	DE, GRATI	BL
10089	7E	0113		LD	A, (HL)	

puter to send more.

When I wrote a routine that used the control-S and control-Q characters to permit the DEC-20 to catch up, the latter would occasionally produce a <bel> (an ASCII 7), and subsequent investigation showed that characters had been lost. There is a bug in the DEC-20 software that causes it to send the control-S too late!

My current approach has proven much more successful and should work for almost any computer installation. I never let the echo fall more than one line behind. During block transmissions, I use BSOUT (lines 337 to 363) instead of SEROUT (lines 191 to 201). BSOUT acts just like SEROUT except that when it must transmit a <CR>, it does not return to the calling program (lines 349 to 351) but proceeds to LWAIT, which waits for a <LF> before allowing a return to the program that called BSOUT.

If LWAIT merely did nothing until a <LF> came echoing

back, then we would miss the display of the last few characters in each line. So LWAIT takes every character it receives and forwards it to FSEND, which behaves much like the send in the monitor's ROM except that it filters out control characters for special attention. The <CR> and <LF> cause no problems for SEND; they are not filtered out.

Thus far I have received <null>s (usually at the beginning of a new line) and <bell>s. I have written FSEND to ignore the former and display "<BELL>" for the latter (using lines 384 through 396). Since I need to be aware of any other possible control codes, FSEND will type out the hexadecimal value of any such control character and follow it with four equal signs for an eye-catching effect (lines 376 through 383).

If the block transmission is terminated because QCKCHK has detected a keypress, the next RAM address that was to be used will be displayed. The rest of the line on the TV monitor will be filled with >s so that I can quickly locate this information. (These tasks are done by ADONE, starting at line 266.)

Otherwise, the block transmission will terminate when the MEOF character is found in RAM. Control is transferred to OUTEND (line 289), which sends the character CCEOF (defined at line 35), which is a control-Z for the DEC-20 system. This character signifies to the large computer that the file is to be closed. After the CCEOF has been output, control goes to ADONE.

When I started writing the block output routine BOUT, I did not realize how much effort it would require. Nevertheless, I am pleased with the result; now I can burden the large computer with large files, and have confidence that they will be received intact.

Receiving Files

To use this feature to load a file from the large computer to my RAM starting at location 1800H, for example, I would type a command to the large computer that would cause it to type the file without pause on my "terminal," but I would leave out the <CR>. That completes the command. Most computer systems will not act upon a command until they receive this <CR>. I then type the special-graphics character, an R, a space and the address 1800. The screen will display @TYPE LIST7<<<R 1800

The first part of the line depends upon the commands that the large computer recognizes and the name of the file you want.

If everything appears in order, I then type a <CR>. My program then figures out what I want and sends a <CR> to the computing center. The DEC-20 then proceeds to type LIST7 (or whatever file I chose), which then appears on my display as well as being placed in my RAM.

When typing is complete or I do not want any more, I hit the key RUN/STOP. My program will then place a <CR>, a <LF> and the MEOF into RAM to

complete what it has recorded. Control then passes to ADONE, which will show the address in memory of the next available byte.

Writing the block input routine, BINP (lines 293 through 321), was straightforward, but it was necessary to filter the incoming stream of characters to eliminate the <null>s (which happen to be my MEOF) before they could enter RAM. Otherwise, my files in RAM got all chopped up!

Viewing Files

My program permits examination of ASCII files in RAM without interaction with the computer center. After you type the special-graphics character, V, space, a hexadecimal address and a <CR>, the ASCII file will be displayed on the monitor at a rate of about 100 characters per second. As with sending files, the display will terminate with MEOF found in RAM or upon QCKCHK's seeing a keypress. Upon termination, a hexadecimal address will be displayed.

I had no problems writing VIEW (lines 202 through 221). I must emphasize that the display rate is determined by VDLY (defined in line 24 and used in line 209).

Implementation

With the aid of the accompanying program listing, you should be able to place the program in your Sorcerer even without the aid of an assembler. I wrote the program with this aim in mind by providing for the selection of various options without the need for reassembly.

This is a relocatable assembly listing. To relocate the program, just add the address of another location to all addresses in the listing that have a single quote sign (or apostrophe) next to them. With this in mind, it is a simple matter to use the (EN)TER command of the Sorcerer's monitor to put the program in service.

First, you should try to set the "dumb" functions to operate properly. SEROUT is currently written to generate even parity



1008A	CBFF	0114		SET	7:4
,008C	D1	0115		POP	DE
'008D	CB60	0116		BIT	4 - P
'008F	2826	0117		JR SET	Z,FINOP-\$
'0091 '0093	CBF7 1822	0118		JR	6-A FINOP-*
10095	D5	0120	NOGRAP	PUSH	DE
10096	CB68	0121		BIT	5,B
10098	2805	0122		JR	Z,SKIP1-\$
1009A	11BEEC	0123		LD	DE, CONTBL
'009D	1815	0124	SKIP1	JR BIT	SKIP4-\$
'009F	CB60 2805	0126	SKILI	JR	Z,SKIP2-\$
'00A3	110EED	0127		LD	DE, SHITBL
'00A6	180C	0128		JR	SKIP4-\$
'00A8	CB58	0129	SKIP2	BIT	3 - B
'00AA	2805	0130		JR	Z,SKIP3-\$
'00AC	115EED	0131		LD JR	DE,SLOTPL SKIP4-\$
'00B1	1803 11AEED	0133	SKIP3	LD	DE, UNSTBL
'00B4	19	0134	SKIP4	ADD	HL, DE
'00B5	D1	0135		POP	DE
'00B6	7E	0136		LD	A, (HL)
'00B7	CBE3	0137	FINOP	SET	4 = E
'00B9	CBDB	0138		SET	3,E 2,E
'00BB	CBBB	0139		RES	7,E
OOBF	E1	0141		POP	HL
'00C0	F5	0142		PUSH	AF
'00C1	ED78	0143	WAITK	IN -	A ₇ (C)
'00C3	A5	0144		AND	L Z,WAITK-\$
0006	28FB F1	0145		JR POP	AF AF
10007	180B	0147		JR	BITEND-\$
10009	CB05	0148	ABIT1	RLC	L
OOCB	3E20	01.49		L.D	A+20H
,00CD	BD	0150		CP	L
OOCE	2002	0151		JR .	NZ,SKIP5-#
'00D0	DD23	0152	SKIP5	SET	2,E IX
'00D4	CB53	0154	BITEND	BIT	2,E
'00D6	CA3800'	0155	2.1.112	JP	Z,BLOOP
'00D9	CB93	0156		RES	2,E
OODB	CB5B	0157		BIT	3 , E
OODD	2007	0158		JR	NZ, SECEND-\$
'00DF	24 3E90	0159		LD	H A,90H
'00E2	BC	0161		CP	Н
'00E3	C23400'	0162		JP.	NZ,SLOOP
100E6	CB9B	0163	SECEND	RES	3,E
,00E8	37	0164		SCF	
100E9	CB7B	0145		BIT	7,E
,00EB	2803 AF	0166		JR XDR	Z,SKIP6-\$
OOEE	CBE3	0168		SET	4,E
'00F0	CB63	0169	SKIP6	BIT	4 - E
'00F2	2003	0170		JR	NZ,FINEND-\$
'00F4	C32B00'	0171		JP	MLOOP
100F7	DDE1 E1	0172	FINEND	POP POP	IX
100FA	D1	0174		POP	DE
OOFB	Ci	0175		POP	BC
OOFC	B7	0176		OR	A
OOFD	2803	0177		JR	Z,KEYRET-\$
OOFF	FD776C	0178	177.020.000.000.000	LD .	(IY+LSTKEY) +A
0102	FDE1	0179	KEYRET		
				POP	IY
0104	F5	0180	INPIFR	PUSH	AF
0105	F5 DBFD	0180		PUSH IN	AF (OFDH)
	F5	0180		PUSH	AF
'0105 '0107 '0109 '010B	F5 DBFD CB4F 2002 F1	0180 0181 0182 0183 0184		PUSH IN BIT JR POP	AF Ar(OFDH) 17A
'0105 '0107 '0109 '010B '010C	F5 DBFD CB4F 2002 F1 C9	0180 0181 0182 0183 0184 0185	INPIFR	PUSH IN BIT JR POP RET	AF Ar(OFDH) 1rA NZrSHOW-\$ AF
'0105 '0107 '0109 '010B '010C '010D	F5 DBFD CB4F 2002 F1 C9 DBFC	0180 0181 0182 0183 0184 0185		PUSH IN BIT JR POP RET IN	AF A;(OFDH) 1;A NZ;SHOW-\$ AF
'0105 '0107 '0109 '010B '010C '010D '010F	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF	0180 0181 0182 0183 0184 0185 0186 0187	INPIFR	PUSH IN BIT JR POP RET IN RES	AF A;(OFDH) 1;A NZ;SHOW-\$ AF A;(OFCH) 7;A
'0105 '0107 '0109 '010B '010C '010D	F5 DBFD CB4F 2002 F1 C9 DBFC	0180 0181 0182 0183 0184 0185	INPIFR	PUSH IN BIT JR POP RET IN	AF A;(OFDH) 1;A NZ;SHOW-\$ AF
'0105 '0107 '0109 '0108 '010C '010D '010F '0111 '0114 '0115	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CDOCEO F1 C9	0180 0181 0182 0183 0184 0185 0186 0187 0188 0189	INPTFR	PUSH IN BIT JR POP RET IN RES CALL POP RET	AF Ar(OFDH) 1rA NZrSHOW-\$ AF Ar(OFCH) 7rA SEND AF
'0105 '0107 '0109 '0108 '010C '010D '010F '0111 '0114 '0115 '0116	F5 DBFD CB4F 2002 F1 C9 DBFC CD0CEO F1 C9 F5	0180 0181 0182 0183 0184 0185 0186 0187 0188 0189 0190	INPTFR SHOW SEROUT	PUSH IN BIT JR POP RET IN RES CALL POP RET PUSH	AF A+(OFDH) 1+A+DW-4 AF A+(OFCH) 7+A SEND AF
'0105 '0107 '0109 '0108 '010C '010D '010F '0111 '0114 '0115 '0116 '0117	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CLOCEO F1 C9 F5 DBFD	0180 0181 0182 0183 0184 0185 0186 0187 0189 0190 0191 0192	INPTFR	PUSH IN BIT JR POP RET IN RES CALL POP RET PUSH IN	AF Ar(OFDH) 1rA NZrSHOW-\$ AF Ar(OFCH) 7rA SEND AF Ar(OFDH)
'0105 '0107 '0109 '0108 '010C '010D '010F '0111 '0114 '0115 '0116	F5 DBFD CB4F 2002 F1 C9 DBFC CD0CEO F1 C9 F5	0180 0181 0182 0183 0184 0185 0186 0187 0188 0189 0190	INPTFR SHOW SEROUT	PUSH IN BIT JR POP RET IN RES CALL POP RET PUSH	AF A+(OFDH) 1+A+DW-4 AF A+(OFCH) 7+A SEND AF
'0105 '0107 '0109 '0108 '010C '010B '010F '0111 '0114 '0115 '0116 '0117 '0117	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47	0180 0181 0182 0183 0184 0185 0186 0187 0189 0190 0191 0192 0193	INPTFR SHOW SEROUT	PUSH IN BIT JR POP RET IN CALL POP RET PUSH IN BIT	AF Ar(OFDH) 1rA NZrSHOW-\$ AF Ar(OFCH) 7rA SEND AF Ar(OFDH) OrA
(0105 (0107 (0109 (0108 (0100 (0100 (0107 (0111 (0114 (0115 (0116 (0117 (0119 (0118 (011E (0120	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1	0180 0181 0182 0183 0184 0185 0186 0187 0198 0190 0191 0192 0193 0194 0195 0196	INPTFR SHOW SEROUT	PUSH IN BIT JR POP RET IN RES CALL POP RET FUSH IN BIT CALL JR POP	AF Ar(OFDH) 1.ASHOW-\$ AF Ar(OFCH) 7.A SEND AF Ar(OFDH) 0.A INPIFR 2.WBE-\$ AF
'0105 '0107 '0108 '0108 '0100 '0101 '0111 '0114 '0115 '0116 '0117 '0118 '0118 '011E '0120 '0121	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 CD0401 28F7 F1 A7	0180 0181 0182 0183 0184 0185 0186 0187 0198 0199 0191 0192 0193 0194 0195 0197	INPTFR SHOW SEROUT	PUSH IN BIT JR POP RET IN RES CALL POP RET FUSH IN BIT CALL JR POP	AF AF(OFDH) 17A NZySHOW-\$ AF AF(OFCH) 77A SEND AF AF(OFDH) 07A INPIFR ZyWBE-\$ AF
0105 0107 0109 0108 010C 010D 0111 0114 0115 0117 0118 0118 0118 0118 0120 0121	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 EA2701'	0180 0181 0182 0183 0184 0185 0186 0189 0190 0191 0192 0193 0194 0195 0196 0197 0197	INPTFR SHOW SEROUT	PUSH IN BIT JR POP RET IN CALL POP IN BIT CALL JR POP AND JP	AF Ar(OFDH) 1:ASHOW-\$ AF Ar(OFCH) 7:ASEND AF Ar(OFDH) O:AINPIFR ZrWBE-\$ AF
0105 0107 0109 0108 010C 010D 0111 0114 0115 0116 0117 0118 0118 0121 0122 0122	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 CD0401 28F7 F1 A7	0180 0181 0182 0183 0184 0185 0186 0189 0190 0191 0192 0194 0195 0196 0197 0198	INPTFR SHOW SEROUT	PUSH IN BIT JR POP RET IN RES CALL POP RET FUSH IN BIT CALL JR POP	AF AF(OFDH) 17A NZySHOW-\$ AF AF(OFCH) 77A SEND AF AF(OFDH) 07A INPIFR ZyWBE-\$ AF
0105 0107 0109 010B 010C 010D 010F 0111 0114 0115 0117 0118 0120 0121 0122 0125 0127	F5 DBFD CR4F 2002 F1 C9 DBFC CBBF CDOCEO F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 EA2701' CBFF D3FC C9	0180 0181 0182 0183 0184 0185 0186 0187 0189 0190 0191 0192 0193 0194 0195 0197 0198 0199 0200 0201	SHOW SEROUT WBE	PUSH IN BIT JR POP RET IN RES CALL POP RET IN BIT JR POP AND AND JP SET OUT	AF Ar(OFDH) 1;A NZ;SHOW-\$ AF Ar(OFCH) 7;A SEND AF AF Ar(OFDH) 0;A INPIFR Z;WBE-\$ AF
0105 0107 0109 0106 0106 0107 0111 0114 0115 0116 0117 0119 0118 0120 0121 0122 0125 0127 0127	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD00E0 F1 C9 F5 DBFD CB47 CH0401' 28F7 F1 EA2701' CBFF D3FC C9 CDC601'	0180 0181 0182 0183 0184 0185 0186 0187 0198 0199 0191 0192 0193 0195 0197 0197 0197 0197 0197 0197	SHOW SEROUT WBE	PUSH IN IN IN POP RET IN RES CALL POP RET IN RIT IN BIT JR POP RET JR POP AND JP SET OUT RET CALL	AF AF(OFDH) 17A NZySHOW-\$ AF AF(OFCH) 77A SEND AF AF(OFDH) 07A INPIFR ZyWBE-\$ AF AP
0105 0107 0109 010B 010C 010F 0111 0114 0115 0116 0117 0119 0118 0120 0120 0122 0125 0127 0129 0129	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 CD0701' CBFF D3FC C9 CDC601' 2879	0180 0181 0182 0183 0184 0185 0189 0190 0191 0192 0193 0194 0197 0198 0199 0200 0201 0202 0203	SHOW SEROUT WBE OUTOK VIEW	PUSH IN BIT JR POP RET IN RES CALL POP RET IN RES CALL JR POP AND JP SET OUT RET CALL JR	AF A
0105 0107 0109 0100 0100 0100 0101 0114 0114 0115 0117 0119 0118 0121 0121 0122 0123 0127 0127 0124 0128	F5 DBFD CB4F C9 DBFC CB9F CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 D3FC C9 CDC601' 2879 CDD15E0	0180 0181 0182 0183 0184 0185 0186 0187 0199 0191 0192 0193 0194 0197 0198 0199 0200 0201 0202 0203 0204	SHOW SEROUT WBE	PUSH IN BIT JR POP RET IN RES CALL FOP RET IN RES CALL JR AND JP SET OUT CALL JR CALL JR CALL JR CALL JR CALL JR CALL CALL CALL CALL CALL CALL CALL CAL	AF Ar(OFDH) 1,A NZ,SHOW-\$ AF Ar(OFCH) 7,A SEND AF Ar(OFDH) 0,A INPIFR Z,WBE-\$ AF
0105 0107 0109 0100 0100 01101 0111 0114 0115 0116 0119 0120 0120 0121 0122 0127 0129 0129 0129	F5 DBFD CB4F 2002 F1 C9 DBFC CB8F CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 EA2701' CBFF CD0601' 2879 CD150	0180 0181 0182 0183 0184 0185 0186 0187 0190 0191 0192 0193 0194 0197 0198 0199 0200 0201 0202 0203 0205	SHOW SEROUT WBE OUTOK VIEW	PUSH INT JR POP RET IN	AF AF(OFDH) 17A NZySHOW-\$ AF AF(OFCH) 77A SEND AF AF(OFDH) 07A INPIFR ZyWBE-\$ AF
0105 0107 0109 0100 0100 0100 0101 0114 0114 0115 0117 0119 0118 0121 0121 0122 0123 0127 0127 0124 0128	F5 DBFD CB4F C9 DBFC CB9F CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 D3FC C9 CDC601' 2879 CDD15E0	0180 0181 0182 0183 0184 0185 0186 0187 0199 0191 0192 0193 0194 0197 0198 0199 0200 0201 0202 0203 0204	SHOW SEROUT WBE OUTOK VIEW	PUSH IN BIT JR POP RET IN RES CALL FOP RET IN RES CALL JR AND JP SET OUT CALL JR CALL JR CALL JR CALL JR CALL JR CALL CALL CALL CALL CALL CALL CALL CAL	AF Ar(OFDH) 1,A NZ,SHOW-\$ AF Ar(OFCH) 7,A SEND AF Ar(OFDH) 0,A INPIFR Z,WBE-\$ AF
0105 0107 0109 0100 0100 0101 0111 01114 01115 01116 01117 01118 01120 0121 0122 0125 0127 0129 0129 0121 0125 0135 0136 0137	F5 DBFD CR4F 2002 F1 C9 DBFC CBBF CDOCEO F1 C9 F5 DBFD CD0401 28F7 F1 A7 CBFF D3FC C9 CDC601 2879 CD15E0 C2BE01 13 CBBF	0180 0181 0182 0183 0184 0185 0186 0187 0190 0191 0192 0193 0197 0200 0201 0202 0203 0204 0206 0207 0207 0207	SHOW SEROUT WBE OUTOK VIEW	PUSH BIT JR POP RET IN RES CALL POP RET IN RES CALL JR POP AND SET CALL JR CALL CALL CALL CALL CALL CALL CALL CAL	AF Ar(OFDH) 1;A NZ;SHOW-\$ AF Ar(OFCH) 7;A SEND AF AF Ar(OFDH) 0;A INPIFR Z;WBE-\$ AF A (OFCH);A GETADR Z;QC-\$ QCKCHK NZ;ADONE Ar(DE) DE Z;A
0105 0107 0109 0100 0100 0100 0111 0114 0115 0117 0119 0118 0120 0121 0122 0127 0127 0128 0129 0120 0133 0133 0133 0133 0133	F5 DBFD CB4F C9 DBFC CB9F CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 EA2701' CBFF D3FC C9 CDC601' 2879 CDC601' 2879 CDC601' CBFF C9 CDC601'	0180 0181 0182 0183 0184 0185 0186 0187 0197 0191 0192 0191 0192 0200 0201 0202 0203 0204 0207 0202 0203 0204 0207 0202 0203	SHOW SEROUT WHE OUTOK VIEW BUWLP	PUSH IN BIT JR POP RET IN RES CALL POP RET IN BIT IN BIT JR POP AND JP SET CALL JR LD INC RES LD	AF Ar(OFDH) 1rA NZrSHOW-\$ AF Ar(OFCH) 7rA SEND AF Ar(OFDH) OrA INPIFR ZrWBE-\$ AF
0105 0107 0109 0100 0100 0101 0111 0114 0115 0116 0119 0120 0121 0122 0127 0129 0129 0129 0135 0135 0135 0135 0137 0137	F5	0180 0181 0183 0183 0184 0185 0186 0187 0187 0198 0191 0192 0193 0194 0197 0200 0202 0203 0204 0205 0206 0207 0208 0209 0207 0208	SHOW SEROUT WBE OUTOK VIEW	PUSH IN BIT JR POP RET IN RES CALL POP PUSH IN CALL POP AND JR SET JR JP SET CALL JP LD LD RES LD CALL	AF Ar(OFDH) 1:ANDW-\$ AF Ar(OFCH) 7:A SEND AF Ar(OFDH) 0:A INPIFR Z,WBE-\$ AF AC(OFCH);A GETADR Z,QC-\$ CCKCHK NZ,ADONE Ar(DE) DF ARVDLY INPIFR
01105 01107 01109 01100 01100 01101 01114 01114 01115 01116 01117 01118 01120 01121 01122 01127 01129 01120 01121 01132 01132 01132 01132 01132 01133 01136 01137 01138	F5 DBFD CR4F 2002 F1 C9 DBFC CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 EA2701' CSFF D3FC C9 CDC601' 2879 CD15E0 C2BE01' 13 CBBF CBBF CBBF CBBF CCBBF CCBCBF CCBCBCBF CCBCBCBF CCBCBCBF CCBCBCBF CCBCBCBCB	0.180 0.181 0.182 0.183 0.184 0.185 0.184 0.187 0.197 0.197 0.190 0.191 0.194 0.197 0.198 0.199 0.201 0.202 0.203 0.204 0.207 0.202 0.203 0.204 0.207 0.208 0.209 0.201	SHOW SEROUT WHE OUTOK VIEW BUWLP	PUSH IN BIT JR POP RET IN RES CALL POP RET IN BIT IN BIT JR POP AND JP SET CALL JR LD INC RES LD	AF Ar(OFDH) 1rA NZrSHOW-\$ AF Ar(OFCH) 7rA SEND AF Ar(OFDH) OrA INPIFR ZrWBE-\$ AF
0105 0107 0109 0100 0100 0101 0111 01114 01115 01116 01117 01118 0120 0121 0122 0125 0127 0127 0129 0128 0136 0137 0138 0138 0138 0138 0138 0138 0138 0138	F5	0180 0181 0183 0183 0184 0185 0186 0187 0187 0198 0191 0192 0193 0194 0197 0200 0202 0203 0204 0205 0206 0207 0208 0209 0207 0208	SHOW SEROUT WHE OUTOK VIEW BUWLP	PUSH BIT JR POPP RET IN RES CALL JR POPP RET IN RES CALL JR CALL JC LD CALL JC LD CALL JC LD CC LD LD CC LD LD CC LD LD CC LD LD LD CC LD	AF Ar(OFDH) 1,A NZ,SHOW-\$ AF Ar(OFCH) 7,A SEND AF
0105 0107 0109 0100 0100 0100 0111 0114 0115 0116 0117 0118 0120 0121 0122 0127 0127 0129 0129 0136 0137 0136 0137 0138 0138	F5 DBFD CB4F 2002 F1 C9 DBFC CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 CA2701' CBFF D3FC C9 CDC601' 2879 CDC601' 2879 CDC601' 13 CBBF CD0401' 13 CBBF CD0401' 14 CBBF CD0401' 15 CBBF CD0401' 16 CBBF CD040	0180 0181 0182 0183 0183 0185 0186 0187 0198 0190 0191 0193 0190 0191 0195 0190 0201 0202 0203 0203 0204 0205 0206 0207 0208 0209 0210 0211 0212	SHOW SEROUT WHE OUTOK VIEW BUWLP	PUSH IN BIT JR POP RET IN RES CALL JR POP RET IN BIT JR POP RET IN BIT JR CALL JR CALL JP LD INC CALL JP LD CALL JP LD CALL CP JR CP	AF Ar(OFDH) 1,A NZ,SHOW-\$ AF Ar(OFCH) 7,A SEND AF
0105 0107 0109 0100 0100 0101 0111 01114 0115 0116 0119 0112 0120 0121 0122 0125 0127 0129 0129 0129 0135 0135 0136 0137 0138 0138 0138 0138	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 CDC401' CBFF CD3FC CDC401' 14 13 CBFF CD15E0 CBFF 11 13 CBFF CD1601' 14 15 CBFF CD1601' 16 CBFF CD17 16 CBFF CD17 17 18 CBFF CD18 CBFF CD19 CBFF CD2 CBFF CD2 CBFF CD3 CBFF CD4 CBFF CD5 CBFF CBFF CD5	0180 0181 0182 0183 0183 0183 0184 0185 0190 0191 0192 0190 0191 0195 0197 0202 0204 0202 0204 0205 0204 0205 0207 0201 0202 0203 0204 0205 0207 0201 0202 0201 0202 0203 0204 0205 0207 0207 0207 0207 0207 0207 0207	SHOW SEROUT WHE OUTOK VIEW BUWLP	PUSH BIT JR POP RET IN RES CALP POP RET IN RES CALL JR SET LD CALL JR LD LD CALL DJNZ CPL DJR	AF A
01105 01107 01108 01108 01101 01114 01115 01115 01116 01117 01118 01120 01121 01122 01123 01127 01128 01129 01120 01121 01132 01132 01132 01132 01138 01138 01140	F5 DBFD CR4F 2002 F1 C9 DBFC CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 EA2701' CSFF D3FC C9 CDC601' 2879 CD15E0 C2BE01' 1A 13 CBBF C69 CD0401' 14 13 CBBF C09 CD0401' 2879 CD15E0 C2BE01' 1A 13 CBBF CD0401' 2879 CD0401' 2879 CD05BF CD0401' 2879 CD05BF CD0401' 18 CD0401' 19 CD0401' 10 CBBF CD0	0180 0181 0182 0183 0183 0185 0186 0187 0190 0191 0192 0193 0194 0195 0200 0201 0202 0203 0204 0205 0207 0202 0202 0212 0212 0212 0212	SHOW SEROUT WHE OUTOK VIEW BUWLP	PUSH IN BIT JR POP RET IN RES CALL JR POP AND JSET CALL JP LD INC CALL JP CALL CALL JP CALL CALL JP CALL CALL CALL CALL CALL CALL CALL CAL	AF Ar(OFDH) 1,A NZ,SHOW-\$ AF Ar(OFCH) 7,A SEND AF
0105 0107 0109 0100 0100 0101 0111 0114 0115 0116 0117 0118 0120 0122 0122 0127 0129 0129 0136 0137 0136 0137 0138 0138 0138 0138 0138 0138 0144 0144	F5 DBFD CB4F CO02 F1 CP DBFC CD0CE0 F1 CP F5 DBFD CD0401' 28F7 F1 D3FC CP CD15E0 CD15E0 CD15E0 CD15E0 CD8F CD0401' 13 CBBF CD0401' 14 13 CBBF CD0401' 16 CBF CD0401' 17 CBF CD0401' 18 CBF CD0401' 19 CBF CD0401' 19 CBF CD0401' 10 CBF	0180 0181 0182 0183 0184 0185 0186 0187 0198 0190 0191 0192 0193 0190 0201 0202 0203 0204 0205 0206 0202 0203 0202 0203 0202 0203 0204 0202 0203 0203	SHOW SEROUT WHE OUTOK VIEW BUWLP	PUSH IN BIT JR POP RET IN RES CALL JR POND JR POND JR POND JR POND JR LD LD CALL JR LD LD CALL JR CP JR CP JR CP JR CP JR	AF AF(OFDH) 17-A NZySHOW-\$ AF AF(OFCH) 77-A SEND AF
01105 01107 01108 01108 01101 01114 01115 01115 01116 01117 01118 01120 01121 01122 01123 01127 01128 01129 01120 01121 01132 01132 01132 01132 01138 01138 01140	F5 DBFD CR4F 2002 F1 C9 DBFC CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 EA2701' CSFF D3FC C9 CDC601' 2879 CD15E0 C2BE01' 1A 13 CBBF C69 CD0401' 14 13 CBBF C09 CD0401' 2879 CD15E0 C2BE01' 1A 13 CBBF CD0401' 2879 CD0401' 2879 CD05BF CD0401' 2879 CD05BF CD0401' 18 CD0401' 19 CD0401' 10 CBBF CD0	0180 0181 0182 0183 0183 0185 0186 0187 0190 0191 0192 0193 0194 0195 0200 0201 0202 0203 0204 0205 0207 0202 0202 0212 0212 0212 0212	SHOW SEROUT WHE OUTOK VIEW BUWLP	PUSH IN BIT JR POP RET IN RES CALL JR POP AND JSET CALL JP LD INC CALL JP CALL CALL JP CALL CALL JP CALL CALL CALL CALL CALL CALL CALL CAL	AF Ar(OFDH) 1,A NZ,SHOW-\$ AF Ar(OFCH) 7,A SEND AF
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0105 0107 0109 0100 0100 0100 0111 0114 0115 0116 0117 0118 0120 0121 0122 0127 0129 0129 0136 0137 0136 0137 0138 0138 0138 0140 0144 0144 0148	F5 DBFD CB4F CO02 F1 CP DBFC CD0CE0 F1 CP F5 DBFD CB47 CD0401' 28F7 F1 A7 EA2701' CBFF D3FC CP CD0501' 28F0 CD0601' 28F7 F1 CP CD0401' 28F7 CP CD0401' 28F7 CP CD0401' 28F7 CP CD0401' 28F7 CP CD05001' 28F7 CD0401' 13 CBBF CD0401' 14 CBBF CD0401' 14 CBBF CD0401' 15 CB	0180 0181 0182 0183 0183 0185 0186 0187 0190 0191 0192 0193 0194 0195 0200 0201 0202 0203 0204 0207 0202 0203 0214 0215 0217 0216 0217 0217 0217 0217 0217 0217 0217 0217	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP	PUSH BIT JR POPP RET IN RES CALL JR POPP AND JSET CALL JR	AF Ar(OFDH) 1,A NZ,SHOW-\$ AF Ar(OFCH) 7,A SEND AF
0105 0107 0108 0100 0101 0111 01114 01115 01116 01117 01118 01120 01121 0122 0122 0122 0123 0129 0129 0121 0129 0135 0135 0135 0136 0137 0138 0138 0138 0138 0144 0144 0144 0144 0146 0147 0147 0147 0148	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 CD0401' CBFF C1 C2879 CD15E0 C28E01' 1A 13 CBFF CD0401' 16 F5 CBFF CD0401' 17 CBFF CD0401' 18 CBFF CD0502 CBCD0401' 18 CBFF CD0502 CBCD0401' 18 CBFF CD0502 CBCD0401' 10 CBFF CD0401' 10 CBFF CD0502 CBCD0401' 10 CBCD0502 CBCD0	0180 0181 0182 0183 0183 0183 0184 0185 0190 0191 0192 0190 0191 0195 0197 0202 0204 0201 0202 0203 0204 0213 0214 0215 0216 0217 0218 0219 0219 0219 0219 0219 0219 0219 0219	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ********	PUSH BIT JR POP RET IN RES CALP FUSH IN RES CALL JR POP AND SET CALL JR CALL J	AF AF(OFDH) 1:ASHOW-\$ AF AF(OFCH) 7:ASHOW-\$ AF AF AF(OFCH) 7:ASHOW-\$ AF AF AF(OFDH) O:AINPIFR Z;WBE-\$ AF AF AC(OFCH);AG GETADR Z;AGD-\$ CCKCHK NZ;ADONE A;(DE) DE 7;AG Z;WCRLF-\$ LF Z;BVWLP-\$ SEND BVWLP-\$ SEND BVWLP-\$ SEND BVWLP-\$ SENTRY************************************
01105 01107 01108 01106 01107 01114 01115 01116 01117 01119 01118 01120 01121 01122 01127 01129 01120 01217 01121 01221 01325 01327 01336 0137 0138 0138 0140 0144 0144 0144 0144 0144 0147 0154	F5 DBFD CR4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CR47 CD0401' 28F7 F1 A7 EA2701' CCBFF D3FC C9 CDC6001' 2879 CD15E0 C2BE01' 13 CBBF COP CD6001' 2879 CD15E0 C2BE01' 14 CBBF CD0401' 15 CBBF CD0401' 16 CBBF CD0401' 17 CBBF CD0401' 18 CBBF CD05001' CBBF CD	0180 0181 0182 0183 0183 0184 0185 0190 0190 0191 0192 0193 0190 0191 0197 0200 0201 0202 0204 0205 0207 0202 0204 0205 0211 0212 0215 0217 0217 0217 0217 0217 0217 0217 0217	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ********	FUSH BIT JR POPP RET IN RES CALL JR POPP SET IN BIT JR POPP AND JSET CALL JP LD INC CALL JR CP CP JR CR CP JR CR CP JR CR	AF Ar(OFDH) 1;A NZ;SHOW-\$ AF Ar(OFCH) 7;A SEND AF AF Ar(OFDH) 0;A IINPIFR Z;WBE-\$ AF AC
0105 0107 0108 0100 0100 0101 0111 0114 0115 0116 0117 0119 0118 0120 0121 0122 0127 0129 0129 0135 0135 0135 0136 0137 0138 0138 0144 0144 0146 0146 0147 0146 0147 0147 0148 0148 0148 0148 0148 0148 0148 0148	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 CD0401' CBFF C1 C2879 CD15E0 C28E01' 1A 13 CBFF CD0401' 16 F5 CBFF CD0401' 17 CBFF CD0401' 18 CBFF CD0502 CBCD0401' 18 CBFF CD0502 CBCD0401' 18 CBFF CD0502 CBCD0401' 10 CBFF CD0401' 10 CBFF CD0502 CBCD0401' 10 CBCD0502 CBCD0	0180 0181 0182 0183 0183 0183 0184 0185 0190 0191 0192 0190 0191 0195 0197 0202 0204 0201 0202 0203 0204 0213 0214 0215 0216 0217 0218 0219 0219 0219 0219 0219 0219 0219 0219	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ********	PUSH BIT JR POP RET IN RES CALP FUSH IN RES CALL JR POP AND SET CALL JR CALL J	AF AF(OFDH) 1:ASHOW-\$ AF AF(OFCH) 7:ASHOW-\$ AF AF AF(OFCH) 7:ASHOW-\$ AF AF AF(OFDH) O:AINPIFR Z;WBE-\$ AF AF AC(OFCH);AG GETADR Z;AGD-\$ CCKCHK NZ;ADONE A;(DE) DE 7;AG Z;WCRLF-\$ LF Z;BVWLP-\$ SEND BVWLP-\$ SEND BVWLP-\$ SEND BVWLP-\$ SENTRY************************************
0105 0107 0109 0108 0100 0101 0111 0114 0115 0112 0120 0121 0122 0122 0122 0122	F5 DBFD CB4F CP8F CD0CE0 F1 CP9 F5 DBFD CB47 CD0401' 28F7 F1 A7 EA2701' CBFF D3FC CP CD05601' 2879 CD0401' 2879 CD0401' 2879 CD0401' 13 CBBF CO0 C2BE01' 14 13 CBBF CD0401' 13 CBBF CD0401' 13 CBBF CD0401' 14 15 CBBF CD0401' 15 CBBF CD0562 18 CD0562 18 CD0562 18 CD0562 18 CD0562 18 CD07745 18 CD0421 18 CD04	0180 0181 0182 0183 0183 0185 0186 0187 0190 0191 0192 0193 0190 0191 0202 0203 0204 0205 0204 0205 0202 0203 0212 0213 0212 0213 0217 0218 0217 0218 0217 0218 0217 0218 0217 0218 0217 0218 0217 0218 0217 0218 0217 0218 0217 0218 0217 0218 0217 0218 0218 0219 0219 0219 0219 0219 0219 0219 0219	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ********	PUSH IN BIT JR POP RET IN RES CALL JR POP AND JP SET CALL JP LD INC CALL JP LD INC CALL JP LD INC CALL JP LD INC CALL JP LD	AF Ar(OFDH) 1,A NZ,SHOW-\$ AF Ar(OFCH) 7,A SEND AF
0105 0107 0108 0100 0101 0111 01114 0115 0116 0117 0118 0120 0120 0122 0122 0122 0123 0125 0127 0127 0128 0136 0136 0136 0137 0138 0148 0148 0148 0148 0148 0148 0148 014	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 CBFF D3FC C9 CDC601' 2879 CD15E0 C28E01' 13 C3 CBBF C00401' 10FB FE00 2800 C2B001' 10FB FE00 2810 CBBF CD0401' 10FB FE00 2810 CBBF CD05E0 CBBF	0180 0181 0182 0183 0183 0183 0184 0185 0190 0191 0192 0193 0199 0199 0201 0202 0203 0204 0207 0202 0203 0204 0211 0212 0213 0214 0215 0216 0217 0216 0217 0218 0219 0219 0219 0219 0219 0219 0219 0219	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ********	PUSH IN IN JR POP RET IN RES CALP FUSH IN RES CALL JP POP AND SET CALL JP LD CALL JR CALL JR CALL JR CALL JR CALL JR CALL JR CALL LD CR LD	AF A+(OFDH) 1+A AF A+(OFCH) 7+A SEND AF AF AF(OFDH) 0+A AF
01105 01107 01108 01101 01101 01114 01115 01116 01119 01118 01120 01121 01122 01127 01128 01129 01129 01132 01137 01138 01136 01137 01144 01146 01151 0151 0	F5 DBFD CR4F 2002 F1 C9 DBFC CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 EA2701' CSFF D3FC C9 CDC601' 2879 CD15E0 C2BE01' 13 CBBF E00 2889 CD0401' 13 CBBF E00 2899 CD15E0 CD05E2 18D9 CD05E2 18D9 CD05E2 18D9 CD0300' 28F0	0180 0181 0182 0183 0184 0185 0184 0185 0184 0185 0184 0185 0189 0190 0191 0192 0193 0204 0205 0204 0205 0201 0212 0212 0212 0212 0212 0212	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ********	PUSH IN IN JR POP RET IN RES CALL JR POP AND JSET CALL JP LD INC CALL JR LD	AF Ar(OFDH) 1;A NZ;SHOW-\$ AF Ar(OFCH) 7;A SEND AF
0105 0107 0108 0100 0101 0111 0114 0115 0116 0117 0119 0118 0120 0122 0122 0127 0129 0129 0121 0129 0135 0135 0136 0137 0138 0138 0144 0144 0144 0145 0146 0147 0158 0158	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401' 28F7 F1 A7 CD0401' CBFF C1 C9 CDC401' CBFF C1 C9 CDC401' CBFF C1 C1 CBFF C	0180 0181 0182 0183 0183 0183 0184 0185 0190 0191 0192 0190 0191 0195 0197 0202 0201 0202 0203 0204 0213 0214 0215 0215 0216 0217 0218 0219 0219 0219 0219 0219 0219 0219 0219	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ********	PUSH BIT JR POPP RET IN RES CALL JR POPP AND SET CALL JR CALL JR LD CALL JR LD	AF Ar(OFDH) 1;ASHOW-\$ AF Ar(OFCH) 7;A AF Ar(OFCH) 7;A AF Ar(OFDH) 0;A INPIFR AF
01105 01107 01108 01101 01101 01114 01115 01116 01119 01118 01120 01121 01122 01127 01128 01129 01129 01132 01137 01138 01136 01137 01144 01146 01151 0151 0	F5 DBFD CR4F 2002 F1 C9 DBFC CD0CE0 F1 C9 F5 DBFD CR47 CD0401' 28F7 F1 A7 EA2701' CR9 CD15E0 C28E01' 13 C88F CD0401' 2879 CD15E0 C28E01' 14 T3 CBBF CD0401' 13 CBBF CD0401' 14 CBBF CD0401' 15	0180 0181 0182 0183 0184 0185 0184 0185 0184 0185 0184 0185 0189 0190 0191 0192 0193 0204 0205 0204 0205 0201 0212 0212 0212 0212 0212 0212	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ********	PUSH IN IN JR POP RET IN RES CALL JR POP AND JSET CALL JP LD INC CALL JR LD	AF Ar(OFDH) 1;A NZ;SHOW-\$ AF Ar(OFCH) 7;A SEND AF
01105 01107 01108 01108 01108 01109 01109 01109 01111 01114 01115 01116 01117 01118 01120 01121 01122 01127 01127 01128 01127 01132 01132 01132 01133 01136 01137 01138 01140 01140 01144 01146 01147 01159	F5 DBFD CR4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401 28F7 F1 A7 CBFF D3FC C9 CDC4001 C87 CDC401 13 C9 CDC401 10FB FE00 28F0 CD0401 10FB FE00 28F3 FE00 28F3 FE00 28F3 FE00 CBBF CD0401 10FB FE00 28F3 FE00 28F3 FE00 28F3 FE00 CBCDCE0 CD05E2 CD05E2 CD0300 CBFF CD03000 CBFF CD05 CD1601 18E7	0180 0181 0182 0183 0183 0185 0186 0187 0190 0191 0192 0193 0197 0193 0197 0200 0201 0202 0203 0204 0205 0207 0205 0207 0210 0211 0212 0215 0216 0217 0216 0217 0218 0218 0219 0219 0219 0219 0219 0219 0219 0219	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ;************************************	PUSH IN IN JR POP RET IN RES CALP FUSH IN RES CALP FUSH IN RES CALP FUSH IN CALL JR CALL JP CALL JP CALL JP CALL JP CALL JR CALL CALL CALL CALL CALL CALL CALL CAL	AF A;(OFDH) 1;A AP A;(OFCH) 7;A AF A;(OFCH) 7;A AF AF A;(OFDH) O;A INPIFR AF
01105 01107 01108 01106 01101 01111 01114 01115 01116 01117 01118 01120 01121 01122 01127 01129 01127 01129 01137 01137 01136 01137 01136 01137 01140 01140 01140 01140 01140 01140 01140 01140 01140 01140 01140 01140 01140 01151 01151	F5 DBFD CB4F 2002 F1 C9 DBFC CBBF CD0CE0 F1 C9 F5 DBFD CB47 CD0401 28F7 F1 A7 CD0401 28F7 F1 A7 CD05601 13 CBFF CD287 CD15E0 C28E01 14 13 CBBF CD1601 13 CBBF CD1601 13 CBBF CD1601 10 10 10 10 10 10 10 10 10 10 10 10 1	0180 0181 0182 0183 0183 0185 0186 0187 0190 0191 0192 0193 0197 0193 0197 0200 0201 0202 0203 0204 0205 0207 0205 0207 0210 0211 0212 0215 0216 0217 0216 0217 0218 0218 0219 0219 0219 0219 0219 0219 0219 0219	SHOW SEROUT WBE OUTOK VIEW BVWLP VDLYLP VCRLF ********	PUSH BIT JR POPP RET IN RES CALL JR POPP SET IN CALL JR POPP AND JR CALL CALL JR CALL CALL CALL CALL CALL CALL CALL CAL	AF A+(OFDH) 1+A+DH 1+A+DH AF A+(OFCH) 7+A AF A+(OFCH) 7+A SSEND AF AF A+(OFDH) O+A INPIFR Z+WBE-* AF A (OFCH)+A GETADR Z+QQ-* QCKCHK NZ+ADONE A+(DE) DE 7+A B+VDLY INPIFR Z+ADONE-* CR Z+AD



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'0172 '0174	FEEF 20E0	0234		CP JR	OEFH #GS	,,,
10176	210300'	0236		LD	HL,KEYBD2	PATCH
′0179 ′017C	FD7541 FD7442	0237		LD LD	(IY+41H),L (IY+42H),H	#ONOTOR
'017F	FD364300	0239		LD	(IY+43H),0	#NO BATCH
'0183 '0185	3E3C	0240		LD	A,'<' B,3	PROMPT
10187	CDOCEO	0242	PLP	CALL	SEND	9'<'
'018A '018C	10FB CD3AE1	0243		DJNZ	PLP-\$ MINPUT	
'018F	FDE5	0245		PUSH	IY	
10191	E1	0246		POP	HL FTOKEN	
'0192 '0195	CD25E2 2819	0248		JR	Z,DONE-\$ PRE	EMATURE <cr></cr>
'0197	FE53	0249		CP .	'S'	
'0199 '019B	2832 FE52	0250		JR CP	Z,BOUT-\$	
'019D	2859	0252		JR	Z,BINP-\$	
'019F '01A1	FE56 2887	0253		CP- JR	Z,VIEW-\$	
'01A3	FE58	0255		CP	'X'	
01A5 01A8	CAOOEO 3E3F	0256	QQ	JP LD	Z,OEOOOH;COI	D START
'01AA	CDOCEO	0258		CALL	SEND	
'01AD	CDOCEO 3E3E	0259	DONE	CALL	SEND A,'>'	
'01B2	0640	0261		LD	B,64	
'01B4 '01B7	10FB	0262	DONELP	DJNZ	SEND DONELP-\$	
'01B9	CD05E2	0264		CALL	CRLF -	
'01BC	1898 CD05E2	0265	ADONE	JR CALL	TERMNL-\$	
'01C1	CDE8E1	0267	PIA. CIVIL	CALL	MUNCNV	
'01C4 '01C6	18EA CD2FE2	0268	GETADR	JR CALL	DONE-\$ GTOKN2	
'01C9	C8	0270	J	RET	Z.	
'01CA	C33DE2	0271	BOUT	JP CALL	MCONVA GETADR	
'01D0	28D6	0273	5001	JR	Z,QQ-\$	
'01D2	CD15E0	0274	BOUTLP	CALL	QCKCHK NZ,ADONE-\$	
'01D5	20E7	0275		JR LD	A, (DE)	
'01D8	13	0277		INC LD	DE BC,OUTDLY	
'01D9	0101FF CD2F02'	0278 0279	SDLYLP	CALL	BINIFR	
'01DF	10FB	0280		DJNZ	SDLYLP-\$	
'01E1	0D 20F8	0281		JR	NZ - SDLYLF-\$	
'01E4	FEOA	0283	LEDET	CP	LF Z,BOUTLP-\$;	EKTD
'01E6	28EA FE00	0284	LFDFT	JR CP	MEOF	SIX I.F
'01EA	2805	0286		JR	Z,OUTEND-\$	
'01EC	CD4102' 18E1	0287 0288		CALL JR	BSOUT BOUTLP-\$	
'01F1	3E1A	0289	OUTEND	LD	A,CCEOF	
'01F3	CD4102'	0290		CALL JR	BSOUT ADONE-\$	
40450	CDC601'	0292	BINP	CALL	GETADR	
'01F8	28AB	0294	PIME	JR	Z,QQ-\$	
'01FD	3EOD	0295		CALL	A,CR SEROUT	
′01FF ′0202	CD1601'	0290	BINPLP	CALL	OCKCHK	
10205	2019	0298		JR	NZ:INDONE-\$	
10207 10209	DBFD CB4F	0300		BIT	1,A	
'020B	28F5 DBFC	0301		JR IN	Z,BINPLP-\$ A,(OFCH)	
'020D '020F	CBBF	0302		RES	7,A	
'0211 '0213	FE00 28ED	0304		CP JR	MEDF; NOT TH	IS!
10213	FEOA	0303		CP	LF \$NO	WANTED:
10217	2800 12	0307	INMEM	JR LD	Z, INMEM-\$;SI (DE),A	CIP-\$
'0219 '021A	13	0308	TRHEH	INC	DE	
'021B	CD7002'		SKIP	JR .	FSEND BINPLP-\$	
'021E '0220	18E2 3E0D	0311	INDONE	LD	A, CR	
10222	12	0313		LD INC	(DE),A DE	
10223 10224	13 3E0A	0314		LD	A,LF ;IF	
10226	12	0316		LD	(DE),A ; <li DE ;NEI</li 	F> EDED
10227 10228	13 3E00	0317		INC LD	A,MEOF	EDED
1022A	12	0319		LD INC	(DE),A	
1022B 1022C	13 C3BE01'	0320		JP -	ADONE	
					IS USED IN BO IFR TO PERMI	
		0324	# COMPUT	ER TO CO	NTROL TERMINA	
(0005	F5		FRATE O	F TRANSM PUSH	ISSION AF	
1022F 10230	DBFD	0327	PINILK	IN	A, (OFDH)	
10232	CB4F	0328		BIT	1,A	
10234 10236	2002 F1	0329	BOUTRT	JR POP	NZ + BSHOW\$	
10237	C9	0331		RET		
′0238 ′023A	DBFC CBBF	0332	BSHOW	IN RES	A, (OFCH)	
'023C	CD7002'	0334		CALL	FSEND	
′023F ′0240	F1 C9	0335		POP RET	AF	
10241	F5	0337		PUSH	AF	
10242	DBFD CB47	0338	BWBE	IN	A, (OFDH)	
10246	CD2F02'	0340		CALL	BINIFR	
10249	28F7 F1	0341		JR POP	Z,BWBE-\$	
'024B '024C	A7	0343		AND	A	
'024D	EA5202'	0344		JP CET	PE, BOUTOK	
/0250 /0252	D3FC	0345 0346	воиток	OUT	7,A (OFCH),A	
		0347	FLINE H		(AF DESTROY	ED)
10254	CBBF	0348	,	RES	7 • A	
10256	FEOD -	0350		CP	CR NZ	
10258 10259	CD15E0		LWAIT	CALL	NZ QCKCHK	
'025C	CO	0353		RET	NZ	

'025D	DBFD	0354	IN	A, (OFDH)		1
'025F	CB4F	0355	BIT	1 , A		
10261	28F6	0356	JR	Z,LWAIT-\$		
10263	DBFC:	0357	IN .	A, (OFCH)		
10265	CBBF"	0358	RES	7 A		
10267	CD7002'	0359	CALL	FSEND		
1026A	FEOA	0360	CP	LF .		
'026C	C8	0361	RET	Z		
'026D	18EA	0362	JR	LWAIT-\$		
'026F	C9	0363	RET	, , =		
10270	FE20	0364 FSEND	CP .	NC - SEND		
10272	D20CE0	0365	JP			
10275	FEOD	0366	CP JP	CR		
10277	CAOCEO	0367 0368	CP	Z,SEND LF		
1027A	FEOA	0369	JP	Z,SEND		
1027C 1027F	CAOCEO FEOO	0370	CP	0		
10281	C8	0371	RET	Z		
10282	FE07	0372	CP.	07H		
10284	2816	0373	JR	Z,BELL-\$		
0204	2010	0374 #MUST	BE SOME O			
		0375 #CONTR	OL CHARAC	TER		
10286	F5	0376	PUSH AF			
10287	CDEDE1	0377	CALL	OE1EDH		
'028A	3E3D	0378	LD	A,'='		
'028C	0604	0379	LD	B, 4		
'028E	CDOCEO	0380 SMR	CALL	SEND		
10291	10FB	0381	DJNZ	SMR-\$		
10293	F1	0382	POP	AF		
10294	C9 .	0383	RET			- 44
1>0295		0384 BELMSG				100
10295	3C	0385 DEFB	(5)			
10296	42	0386 DEFB 0387 DEFB	B.			
10297	45		'L'			
10298	4C		'L'			
10299 1029A	4C		,>,			
1029A	3E	0391 DEFB				
'029C	E5	0392 BELL	PUSH	HL		
'029D	219502'	0393	LD	HL, BELMS	3	100
102A0	CDBAE1	0394	CALL	SNDLIN		
'02A3	E1	0395	POP	HL		
102A4	C9	0396	RET			
		0397 *****	****END**	*******	****	
ERRORS=0						
ABIT1		ADONE	01BE BEL		029C	
BELMSG		BINIFR	022F BIN		01F8 0038	
BINPLP		BITEND	OOD4 BLO		0000	
BOUT		BOUTLP	01D2 BOU 0238 BSO		0252	
BOUTRT	0238 012F	BSHOW	0242 CCE		001A	
CODED		CONTBL	ECBE CR	ur	0000	
CRLF		DEBOUN	0042 DON	F	0180	
DONELP		DUPLEX CINT			00F7	
FINOP		FSEND	0270 FT0		E225	
GETADR	0106	GETIY	E1A2 GRA	TBL	EC6E	
GTOKN2	E22F	INDONE	0220 INM	EM	0219	
INPIFR		INSTBL	EC1E KEY		0003	
KEYRET	0102		000A LFD		01E6	
LSTKEY	0060	LWAIT	0259 MC0		E23D	
MEOF		MINPUT	E13A MLO		002B	
MUNCHV		NOGRAP	0095 NON		0062	1 - 1
NONGRA		NONSHI	0068 NOR		0025	
OUTDLY		DUTEND	O1F1 OUT	UK	0127	
PLP REPET		QCKCHK SDLYLP	E015 QQ 01DC SEC	END	01A8 00E6	
SEND		SEROUT	0116 SHI		EDOE	1
SHOW		SKIP	021B SKI		009F	'.
SKIP2		SKIP3	OOB1 SKI		00B4	
SKIP5		SKIP6	OOFO SLO		0034	
SLOTBL		SMARTS	016F SMR		028E	
SNDLIN		TERMNL	0156 UNS	TBL	EDAE	-
VCRLF	0151		OOFF VDL	YLP .	013B	7
VIEW		WAITK	OOC1 WBE		0117	*

signals (the DEC-20 ignores this bit, anyway). By recoding lines 198 and 199, you can have odd parity, mark parity or space pari-

There are many choices to consider associated with the block transfers. In addition to deciding what to do about the parity bit for transmission and for storage in RAM, you should decide whether lines are to be terminated with just <CR> or with both <CR> and <LF>.

There are several places where this decision will affect the code. For example, lines 306 and 307 as coded are not needed (I do need the <LF> in RAM), but if you do not want the <LF> in RAM, the relative destination in line 307 should be changed to "SKIP-\$." There are several places where you may wish to change delay constants, such as VDLY (which is used in VIEW). You may want to also change MEOF and/or CCEOF.

You may have different ideas on how to use the e(X)it command. I have coded it as a jump to the cold-entry point of the monitor (see line 256). This will disable the RS-232 port and reestablish the cassette interface; the baud rate will be changed back to 1200. You may wish to jump to the warm-reentry point of the monitor at 0E003H or to write some more software and jump to that.

I have used this program to work on several projects in addition to developing this article, and I'm sure those of you who try this program will enjoy it.



A Hexadecimal Front Panel for Z-80 Systems

A 4 MHz processor board from Ithaca Intersystems forms the core of this construction.

John D. Ciana 24 Eichstrasse 8045 Zurich Switzerland

his article describes my search for, and utilization of, a processor board. I was looking for an inexpensive Z-80 processor, with all the usual gadgets; but most of all, it had to have a monitor program in ROM.

Unfortunately, none of the boards I looked at met all of the above conditions. Most provided a ROM socket, but no chip. ROM chips that were provided with the boards were usually as dull as when they came out of the production line. The boards were either too expensive, or the monitors resided in low memory.

The one that came the closest

was the Morrow front panel computer board, which is "only" an 8080, and the keyboard and display are in octal. So, I asked myself, "Why a monitor?" With a versatile front panel and a good floppy-disk operating system, you don't need a block move or a memory clear function. So, the question is: What are the desirable features of a modern front panel for a (nearly standard) S-100 computer?

First, it is easy to read the data and address values on the display. Thus, the LEDs are excluded in favor of the hex display to show the state of the buses. Second, there should be a way to enter data without having to toggle all those switches (see Photo 1). Four easy strokes on a hex-encoded keyboard are required, instead of the error-

prone 16 switches to flip up or down. Third, the single-step feature allows you to stop the program and step slowly from then

A novel feature of this front panel is the hardware breakpoint. Just by putting an address on the keyboard display

and flipping the breakpoint switch, you can set a trap that will stop the processor right on that address, if it ever executes through it. This allows the programmer to halt the 'brain' just at the right place, read the memory and then continue process-



Photo 1. Hex-encoded keyboard.

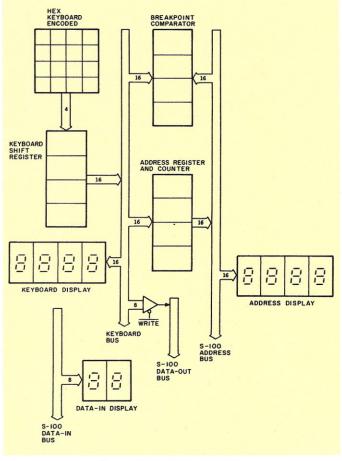


Fig. 1. Front panel overview.

Thus, I decided to build a front panel and to buy an off-the-shelf processor board. I chose a 4 MHz Z-80 processor board from Ithaca Intersystems. It has worked fine since I first powered it up.

What's New

Technology grows so fast these days that by the time you can get the manufacturer's manual on your desk-and we are not left behind here in Europe -the largest OEMs have had their advance copy of specsheets for six months. Thus, as an engineer or hobbyist, you are at least six months behind the state of the art.

I am thinking about using complementary MOS integrated circuits, so the best thing to do is obtain the specification manual of one or two of the biggest MOS chip vendors and use the bonanza of low-cost chips on the market. The highly sophisticated circuits allow you to reduce the package count and to build functions not possible before.

The added advantage is that you can mix existing TTL functions and CMOS by using the LSTTL Schottky family. You must remember that at maximum, two LSTTL loads connect to one CMOS output; don't use

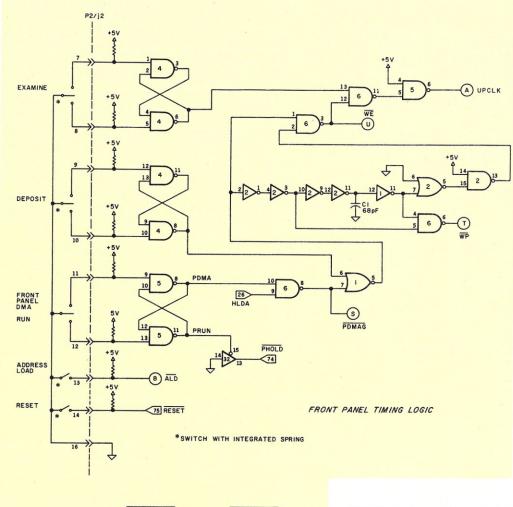
the usual TTL because the output high voltage of 3.5 V is too low to obtain sufficient noise margin when connected to a CMOS input. CMOS technology is five to ten times slower than Schottky TTL, but this is no disadvantage, as we shall see later.

The workhorse of this front panel is the MC14495 latched hex decoder and display driver. No current limiting resistors are needed, because this is taken care of on the chip itself. The MC14572 multigate IC allows an optimal mix of four inverters, one NAND and one NOR on one chip. The added benefit of using CMOS and LSTTL together is much lower power consumption. Thus, only one 5 V regulator is needed on this board.

Surroundings

My front panel board is a "nearly S-100" accessory. I am using a fully static memory board with 300 ns, 2114 memory chips. When the front panel wants the bus, the processor releases it, so there is no fighting for signal lines. The front panel uses DMA techniques, providing all signals necessary to my memory and allowing even the processor board to be removed without affecting Deposit or Examine functions.

Thus, you can't use the refresh counter built in the Z-80 because once the front panel grabs the bus, the processor is Tri-stated away from the bus. If you plan to use dynamic memories, make sure that they use on-board refreshing and that the bus "sees"



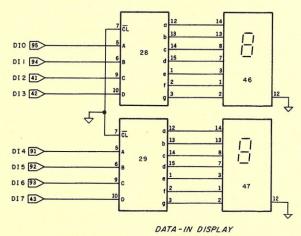


Fig. 2a. Front panel timing logic and Data-in display.



Photo 2.

a static-like memory.

Functional Description

The hexadecimal display contains three lines of 7-segment displays and eight status LEDs in the lower left corner of the display window. The upper line of displays shows the state of the 16-bit keyboard register on its four digits. Each digit represents four bits and is decoded at each of its 16 different states.

The second line represents the 16-bit S-100 Address bus, and the two lower digits represent the 8-bit S-100 Data-in bus. The keyboard register feeds a Keyboard bus that is not part of the S-100 system but is extensively used throughout the board (see Fig. 1). While writing in memory with the Deposit switch, the eight lower bits of the Keyboard bus will be sent out on the Dataout bus (the two rightmost digits

on the keyboard display).

The 16-bit address register and counter will be loaded from the 16-bit keyboard register with the Load Address switch and will count up at each of the Examine or Deposit switch strokes, thus stepping the memory sequentially. Fig. 1 shows the 16-bit breakpoint comparator that gives an equal condition to the breakpoint logic when the Keyboard bus and the Address bus are the

same-at SM1 processor time. This permits you to enter the panel DMA mode and examine and respectively write the memory. By leaving the breakpoint latched state, processing will be resumed.

Figs. 2a, 2b and 2c show more details. Every letter in a circle connects to another figure, while each number in a flag shows an S-100 bus connection. Fig. 2a shows that the S-100 Data-in bus is decoded and displayed constantly thanks to ICs 28 and 29 and displays 46 and 47.

The front panel switches are connected through P2/J2 to the front panel timing logic. I used ground level in the wiring and pull-up resistors in the logic to avoid the +5 V in the wiring, so that any short-circuit will not have disastrous consequences. The reset switch is directly fed to the S-100 bus, having straight action on the processor. The ALD, address load line, when pulsing low, will parallel-load the address counter from the keyboard register (Fig. 2c, ICs 16-19). The address counter is Tri-stated on the bus only when the drivers (ICs 30-33) are enabled during front panel DMA.

The term PDMAG, (panel DMA granted) is generated on Fig. 2a. Once the front panel DMA switch is flipped, the corresponding latch is set, requesting PHOLD to the processor. This one answers with HLDA, thus releasing the buses and granting DMA to the front panel at gate 6, pin 9.

PDMAG enables the address counters on the bus. This address bus is decoded and displayed all the time by ICs 24-27 and 38-41, respectively. The same term also enables Tri-state driver 36, allowing some necessary signals on the bus. The processor Tri-state buffers are disabled by STADSB, ADDDSB, DODSB and CCDSB going low. PSYNC, SOUT and SINP are inactive low in this design. PDBIN and SMEMR are high during a memory read and low during a write, according to WE, write enable.

Inverting buffer 37 will drive six LEDs to show the six statuses, SOUT, SINP, SM1, MRQ, PWAIT and SMEMR. You could display other statuses or add

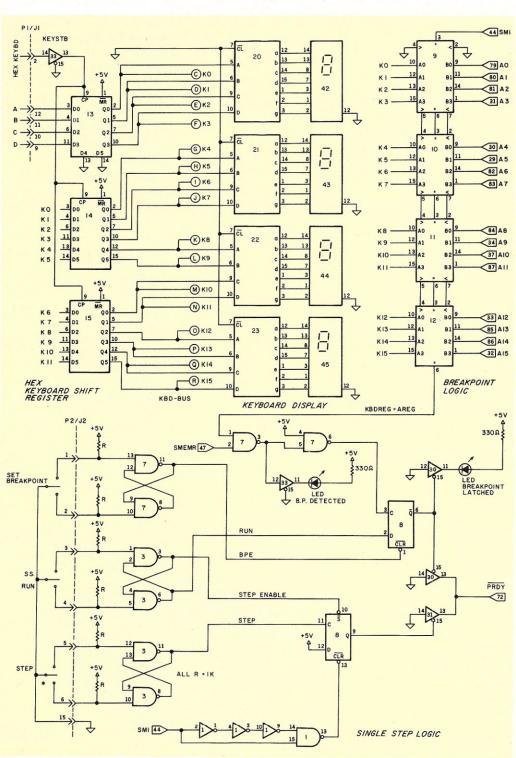


Fig. 2b. Keyboard register circuitry.

Most small system users think all microcomputers are created equal. And they're right. If you want performance, convenience, styling, high technology and reliability (and who doesn't?) your micro usually has a price tag that looks more like a mini. It seems big performance always means big bucks. But not so with the SuperBrain.

Standard SuperBrain features include: twin double-density 51/4" drives which boast over 300,000 bytes of disk storage. A full 32K of dynamic RAM - easily expandable to 64K. A CP/M* Disk Operating System which insures compatibility to literally hundreds of application packages presently available. And, a 12" non-glare, 24 line by 80 column screen.

You'll also get a full ASCII keyboard with an 18 key numeric pad and individual cursor control keys. Twin RS232C serial ports for fast and easy connection to a modem or printer. Dual Z80 processors which operate at 4 MHZ to insure lightning-fast program execution. And the list goes on. Feature after feature after feature.

Better yet, the SuperBrain boasts modular design to make servicing a snap. A common screwdriver is about the only service tool you'll ever need. And with the money you'll save on purchasing and maintaining the SuperBrain, you could almost buy another one. For under \$3,000, it is truly one of the most remarkable microcomputers available anywhere.

Whether your application is small business, scientific or educational, the SuperBrain is certainly one of today's most exciting solutions to your microcomputer problems. Call or write us now for full details on how you can get big system performance without having to spend big bucks. So, why not see your local dealer and try one out today. Intertec systems are distributed worldwide and may be available in your area now.



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SUFERBRAIN



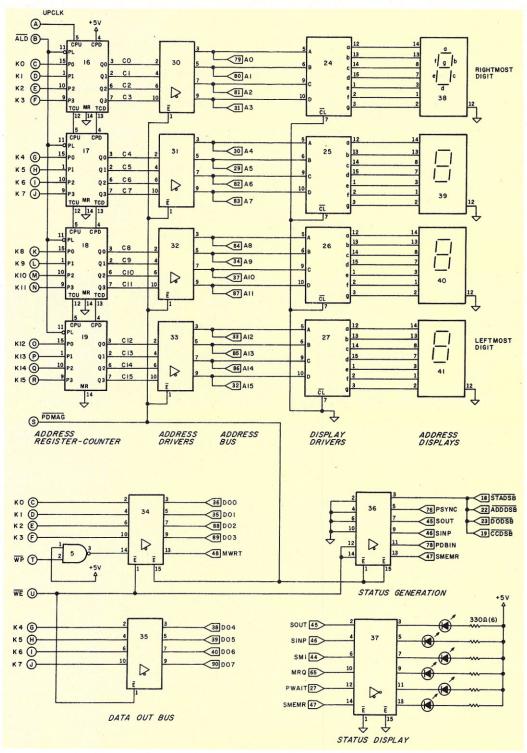


Fig. 2c. Address bus.

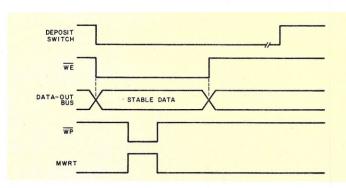


Fig. 3. Write timing.

more LEDs and drivers. On Fig. 2c, the Data-out bus is driven by the eight lower bits of the keyboard register, but only when write enable goes low through Tri-state drivers 34 and 35.

The write clock to memory comes either from the processor (MWRT) or from the front panel (WP) write pulse. For this, the second half of driver 34 is used, with the enable pin 15 tied to

PDMAG. Make sure that MWRT goes Tri-state at the processor during panel DMA.

When not writing, the panel reads memory all the time at the address given by the address register-counter. By toggling the Examine switch, you merely step the counter up by one, through the UPCLK term. Writing in memory is more complex and requires a sequence of signals (see also Fig. 3).

In Fig. 2a, as soon as the Deposit switch is toggled, WE goes low, enabling the Data-out bus drivers. WE is generated on IC6, pin 3, as long as the output signal of IC 1, pin 5, does not yet reach the end of the inverter chain made by the gates of ICs 1 and 2. CMOS gates are slow, and, with the adjunction of C1, I expect WE to be around 500 ns long. Since the generation of WP uses three of the same gates used by WE, I expect WP to go low about 120 ns after WE does and remain low for about 250 ns.

The write pulse occurs when the Data-out bus is long stabilized and stops long before the bus is released. With this timing, I never had any problems writing in memory. You may have to adjust the value of C1, going as low as 20 pF or even removing it, to as high as 100 pF. When $\overline{\text{WE}}$ goes high, the address counter is toggled to the next memory byte by UPCLK.

The keyboard register is shown in Fig. 2b. It is made of three shift register chips, each having six independent bits. It is actually wired in four 4-bit words placed one after the other. I use a commercial keyboard made locally. The hex keyboard by Poly-Packs should be fine for this project.

For those of you who want to build one yourself, mine uses a National MM74C922 encoder chip. The four data bits are true high at connector P1/J1, and the keyboard strobe KEYSTB should pulse low. The decoder-drivers 20–23 and the displays 42–45 show the keyboard bus all the time, and each typed digit will appear on the right and move to the left until it disappears off the display.

The breakpoint logic is made with the comparator ICs 9-12.

When the Keyboard bus and the S-100 Address bus are the same, only the SM1 signal is needed on the equal input on IC9, pin 3. The equal condition will ripple through the comparators and will reach a gate in IC7. This signal NANDed with SMEMR (memory read) will light the "breakpoint detected" LED and will clock the breakpoint flip-flop.

This clocking will only be effective if the clear is removed on the flip-flop, pin 1. The term BPE should be high, that is, the Breakpoint switch flipped on. The setting of the flip-flop will light the "Breakpoint latched" LED and set the PRDY line low to the processor, halting it right at SM1 time.

To leave this situation, flip the switch back to the off position, clearing the flip-flop and releasing the processor. This logic is disabled during single step because it has no use as long as the RUN term is low at the D input of the flip-flop.

The single-step logic is made of the second half of IC8. When the single-step/run switch is on RUN, the STEP ENABLE line is low, setting the flip-flop all the time, albeit clearing pulses coming from SM1. The Q output remains high, disabling the driver in IC31 and leaving the processor alone. In the single-step position, the enable line goes high, and the next SM1 signal from the processor clears the flip-flop.

The pulse generator in IC1 should now seem familiar. The Q output goes low and sends PRDY to the processor, stopping it still at SM1 time. To advance one instruction byte, the Step switch will clock the flip-flop, releasing the processor, but just enough to go to the next SM1

time, thus realizing the singlestep effect.

Construction

Use the flexible wire-wrap construction techniques for this one-time front-panel project. I chose a Vector 8800 V wire-wrap board (see Photo 3). It is important to use a board with vertical PC runs, so that you can place the 7-segment display vertically. The layout is not critical (see Fig. 4 or design your own). Remember to wrap systematically - bus after bus, registers, counters, and miscellaneous logic at the end. In this way, you will avoid forgetting a wire (see Photo 4). Use a liberal amount of decoupling capacitors (every three ICs, for example) on the +5 V bus (0.01 to 0.1 uF).

I bought cut and stripped wire for the shortest lengths, because these are the most difficult to manipulate. It took me six hours to "wrap it up," and I didn't forget a wire. It worked immediately! The places marked R on Fig. 4 are 16-pin wire-wrap sockets, containing 14 resistors. I bought these in flat strips of coated ceramic, containing seven resistors each and having one common pin. Each socket gets two strips.

Tests

Wire-wrap the board, solder the capacitors and wire and solder the +5 V regulator. Unplug all boards from the S-100 bus and plug-in your new board. Power-up. Measure the voltage on the +5 V bus. If the test is positive, plug all ICs and displays, resistors and flat cables to the switches and keyboard, respecting their orientation. Power-up. The display

IC Number	Description
1,2	MC14572 CMOS multigate chip (Motorola)
3,4,5,6,7	74LS00 TTL four 2-input NAND
8	74LS74 TTL double D-flip-flop
9-12	74LS85 TTL 4-bit comparator
13,14,15	74LS174 TTL 6-bit shift register
16-19	74LS193 TTL 4-bit up-down counter
20-29	MC14495 CMOS Hex decoder and display driver (Motorola
30-36	74LS367 TTL Tri-state hex buffers, non-inverting
37	74LS368 TTL Tri-state hex buffers, inverting
38-47	DL 702 LED 7-segment displays, common cathode

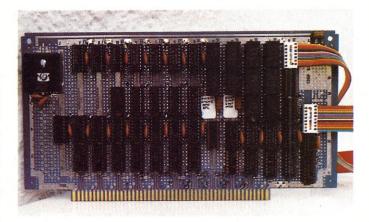


Photo 3. PC board design.

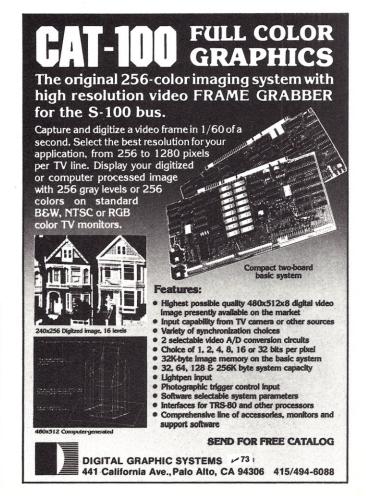
should light up.

Toggle the Examine and Deposit switches when on panel DMA. The address display should count up. Punch a few figures on the keyboard, which should appear on the right and shift to the left of the keyboard display. Power-down. Plug in the memory board. Without the processor, you should be able to read and write to memory. Plug the processor in the S-100 bus.

Now you can try the test

program. If there are malfunctions, try to determine if "fighting" for a line or a set of lines on the bus exists. When in panel DMA, the processor should release the bus. Remember that the Address and Data-in displays show bus data all the time, enabling you to troubleshoot. This program will load the 16-bit BC register from a pair of bytes in memory and store it back at another place. See Table 2.

1. Flip the switch to panel



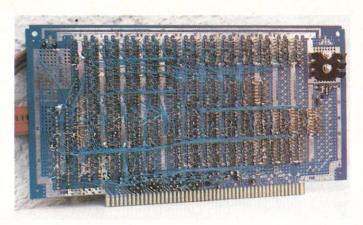


Photo 4. Wire-wrap construction.

DMA.

- Load 0000 in the keyboard display and toggle Load Address.
- Type in ED and toggle the Deposit switch.
- 4. Type in 4B and toggle the Deposit switch.
- Enter 00, 02, ED, 43, 02, 02,
 C3, 00, 00, using the Deposit switch each time, as above.
- Load 0200 in the keyboard display and toggle Load Address.
 - 7. Deposit 55, CC, 00, 00.
- Switch single-step on and panel DMA off.
- Hit Reset. (The processor will begin to execute at 0000.)
- 10. Toggle-step a few times until you see C3 on the Data-in bus. You will then have executed both the load and the store.
 - 11. Switch panel DMA on and

single-step off.

- 12. Check at address 0200. You should get 55, CC, 55 CC, proving that the processor moved data.
- 13. Switch panel DMA off, releasing the full power of your

At address 0000: ED 4B 00 02 ED 43 02 02

Loads contents of addresses 0200 and 0201 in register pair BC. Stores contents of register BC in memory at address 0202 and

C3 00 00 Jumps back to 0000, beginning of program

Table 2. Test program.

Z-80. It should loop forever in this small program, until you try point 14.

- 14. Load 0000 in the keyboard register and flip the Breakpoint switch. It should stop at address 0000, showing ED on the Data-in bus. Both the breakpoint detected and breakpoint latched LEDs should come on. Flip the switch off, and the processor will be released. Try this with other addresses.
- 15. Write other programs and have fun.

16. Write articles.

Conclusion

This article shows a way to speed up program development, using minimum hardware and no support software. It should work with any S-100 system, but has only been tested with the mentioned hardware. It should be easy to boot a disk system by just typing a few digits on the keyboard. If you know where to buy the chips, it should not be expensive.

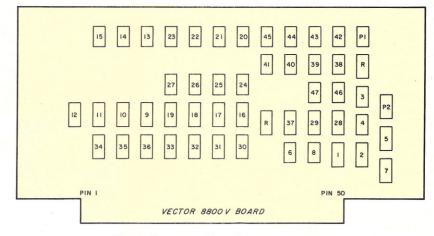


Fig. 4. Front panel board, component side.







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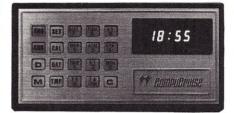
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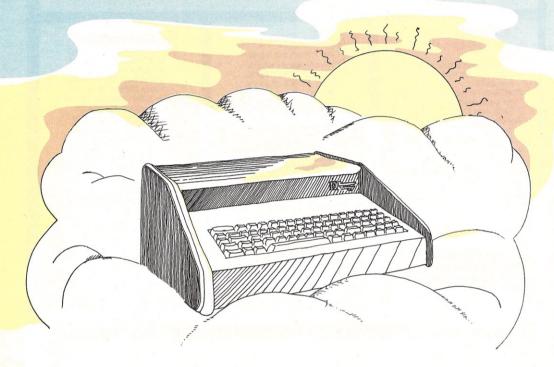
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As the business side of microcomputing becomes bigger and more competitive, and as the giants take over a larger share of the market, it is inevitable that some of the smaller companies will fail. It is just as inevitable that some of you reading this article will soon possess "orphans." It is to you that I address this article.

I own a SoI-20, an 8080A-based microcomputer that I considered one of the best on the market. Unfortunately, it is no longer on the market! One of my first thoughts on hearing of the demise of Processor Technology Corp., the SoI's creator, was to try to unload it on somebody. However, after some clear thinking, it became obvious that the same features that had convinced me to buy this machine two years ago were still there.

I then began a methodical

process to cushion the blow and to protect my investment in the future. It is about this that I am writing, and I hope that some of you reading my article will benefit from my work.

Safety in Numbers

Before buying a microcomputer, you should join its users group. Get as many back issues of their newsletters as possible. These groups have a wealth of knowledge of software bugs and hardware quirks. If Processor Tech had had this much talent on tap, it never would have failed. Users groups can also aid you in evaluating which equipment is compatible with your system. Share your experiences—both your successes and failures—with them.

If a users group is sufficiently large, it can make an offer to a defunct company to buy some of the source listings of the software and distribute them to its members. You will appreciate this when you have to modify your software to interact with that of companies that didn't

even exist when your machine was in production.

Saving for a Rainy Day

The second step is to obtain as much of the documentation—schematics, change notices and source listings—for your equipment as possible. Many of the computer stores that previously carried your brand will be happy to dispose of these and may not even charge you for them. Some computer stores, such as the Computer Port in Arlington, Texas, will sell documentation packages such as these.

Next, you must keep track of the service facilities. Computer stores have a terrible turnover rate, exceeded only by the turnover of technicians. If you know of a technician who seems to know everything about your machine, cultivate his friendship, check to see that he is still on staff at the same store and patronize the new store if he moves to a new one or opens his own. Remember that many of the technicians you may ap-

proach in the future will have no idea of the flukes that are present in your computer.

If you have been planning to add to your system "sometime in the future," now is that time. Software compatibility with your cassette format will quickly dry up. Do you really want to enter an 8K program in BASIC through the keyboard? Modifications that some companies have made to their peripherals, such as floppy disks, will soon disappear with the market. However, don't be stampeded into buying peripherals that use standard outputs such as serial or parallel ports. You should have no difficulty writing your own drivers for them at any time.

Keep your eyes open for companies selling off equipment made by the defunct company. If the equipment was sound before "the fall," it still will be and will cost less. Be prepared to dicker with the owner of the computer shop. He wants to get rid of the merchandise as soon as possible.

Conclusion

The loss of a small computer company is never a propitious event. We all lose. The owner of the company's products is inconvenienced, and we all are deprived of the ingenuity that is the trademark of the small electronics firm. However, I hope I have presented some ideas that will help you to survive the setting of your own personal Sol.

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This program is helpful for making judicious use of reader-service cards.

Howard J. Siegel 15020 North 7th Drive Phoenix, AZ 85023

use the reader-service reply cards in Kilobaud Microcomputing to request information on products and services of advertisers. Wayne encourages us to use these cards because they help to keep readers informed to make intelligent decisions about microcomputer equipment/software purchases. Advertisers can measure the effectiveness of their ads. That helps to keep current advertisers and obtain new ones, providing you and me with an expanded magazine (both in articles and advertising) and the opportunity to circle new readerservice numbers.

To become more informed and to expand the size of the magazine, I remove the card from the back of each issue and keep it with me as I read, looking for new and different ads to make requests from.

However, I read many magazines. Each has its reader-service reply card. Many times I have received duplicate data from the same company because I forgot a previous request from an ad in another magazine. So what? Well, I cost the company needless expenditure. That extra cost may be built into the next piece of equipment or software package I want to buy.

I wrote the accompanying program to help prevent this

from happening. This program allows me to keep track of the companies to whom I have made requests. The basic functions performed are adding, deleting and checking on the information stored.

System Requirements

My system is a Polymorphic 8810 with 32K of RAM and two disk drives, although disks are not required. The program requires about 3.5K of memory and is written in Poly disk BASIC version B08C.

The following are some of the notations that may be unique to Poly BASIC:

DIM L\$(1:50) – this specifies a string array consisting of one member with a maximum length of 50 characters.

MID\$(L\$,I,I) – function that returns the Ith character of the string. MID\$(L\$,I,J) returns the Ith through the Jth characters of the string, inclusively.

ASC(string variable) – function that returns the decimal representation of the ASCII code for the first character in the specified string.

VAL(string variable) – function that returns the numeric value of a numeric string if the

string doesn't contain blanks.

CHR\$(expression) — function that returns a string specified by the expression. This expression is a decimal representation of the ASCII code. CHR\$(12) causes a skip to top of page on a printer or clear screen and home up on a CRT. CHR\$(13) is the equivalent of a carriage return.

ON ERROR – provides the user with control over error-recovery procedures. Use of this statement is explained below.

Program Notes

When I wrote this program, I had not added disk to my system. In order to maintain the information on which companies I had requested literature from, I stored the company name, magazine name and issue date in DATA statements. Poly BASIC provides two features that help to dynamically create and update these DATA statements.

The system has a 64-character "type-ahead" buffer, which allows the operator to manually input data before the program asks for it or to create that input stream as a part of the program itself.

The second Poly feature is the ability of the user to invoke, from

BASIC, an 8080 OUT instruction to a specified port. Port 0 is the type-ahead buffer. The instructions in Example 1 enter each character in the string L\$ into the type-ahead buffer. If the program branches to STOP, the characters in the buffer are read, and the BASIC program line number 10 is either created with or replaced by the contents of the buffer.

If the last string put into the buffer is run, followed by a carriage return (CHR\$(13) in Poly BASIC), the program automatically restarts with the new information in the proper DATA statement. The DATA statements for the literature requested are built into lines at the start of the program. They are built and output to the buffer by the function FNL(L\$) starting in line 1400.

Program Functions

The first is the ADD function. The program simply asks for the input of the data to be saved. I enter company name, magazine requested from and issue date. To keep the output looking neat, with the request for input I put an "I" on the screen to indicate the maximum size allowed for the company name. The program then builds a string using the next available BASIC statement number and outputs it to the buffer.

Another string is created to replace DATA statement 0. This statement contains three indicators: the number of data

1000 L\$ = "10DATA XYZ COMPANY—KB 6-79"

1010 FOR I = 1 TO LEN(L\$)

1020 A\$ = MID\$(L\$,I,I) 1030 OUT0.A\$C(A\$)

1040 NEXT I

Example 1.

Program listing.

```
ODATA 5,0, 0
1DATA"ISI - KB/8-79", 0
2DATA"NEWMAN C.E.- KB/1-79", 0
3DATA"BAMBI INFO - KB/12-78", 0
 4DATA"COMP ENTER - KB/12-78", 0
 5DATA"POLYMORPHICS- KB/8-79",
 999DIML$(1:50),T$(1:25),C$(1:25),X$(1:25)
 1000RESTOREO
 1010READN.G.Z9
 1020IFG=OTHEN1100
 1050IFG=1THEN1210
 1060IFG=2THEN3000
 1070IFG=3THEN4000
 1100PRINTCHR$(12)\PRINTTAB(15),"LITERATURE REQUESTS"\PRINT
 1110PRINT\PRINT\PRINT"CODE
1110PRINT\PRINT\PRINT\CODE"
1120PRINTTAB(3),"1", TAB(10),"CHECK"
1130PRINTTAB(3),"2", TAB(10),"ADD"
1140PRINTTAB(3),"3", TAB(10),"DELETE"
1142PRINTTAB(3),"4", TAB(10),"LIST ALL"
1144PRINTTAB(3),"9", TAB(10),"END OF JOB"
1150PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRINT\PRIN
 1160INPUT"CODE ?",F1
 1170IFF1=1THEN1210
  1180IFF1=2THEN3000
  11901FF1=3THEN4000
  1192IFF1=4THEN5000
 11941FF1=9THEN12000
 1195GOT01160
 1210PRINTCHR$(12)
1220PRINT"ENTER REQUEST TO CHECK
                                                                                                                                        HIT RETURN TO EXIT"
  1222INPUTT$\IFT$=""
                                                                           THEN1100
  12240N ERROR GOTO1250
  1226S1=VAL(T$)\S1=S1+1
  1228RESTORE1
  1230FORI=1TOS1\READ C$,X\NEXT
1232I=I-1\GOTO1310
  1250RESTORE1
  1255L3=LEN(T$)
   1260FORI=1TON\READ C$,X
  1270IF T$=LEFT$(C$,L3)THENEXIT1310
  1 280NEXT
  1290PRINT"NO HIT"
```

statements used, a code to specify where in the program to branch to and an indicator used at end of job. DATA statement 0 is followed in the buffer with a RUN so that the program will recycle itself back to the add routine. To get from the add routine back to the selection screen, just type a carriage return.

Another function is LIST ALL, which lists all the data in the program. Shown with the data is a record number and a delete indicator. The record number is useful in the CHECK mode.

The CHECK function allows rapid checking of a given company's status. The program requests the name of the company and searches the DATA statements for a match. When a match is found, the program displays all of the data contained within the DATA statement. By using the ON ERROR command in Poly BASIC, I am able to enter just the record number, instead of the full name, of the company, and the display is the

same

To illustrate the ON ERROR command, the program requests the name of the company in statement 1222 INPUT T\$. After checking for a null string (T\$ = " "), it assumes that I have entered a number and tries to convert it using the function VAL. If it finds an alphabetic character (I entered the name), an error condition occurs because the function VAL is designed to only handle numeric strings. The program remembers that I had coded an ON ER-ROR statement and then does whatever I specified. In this case, it is a GOTO 1250, where the input string is handled correctly as an alphabetic string. The ON ERROR is a convenient tool not found in all of the extended BASICs.

In the CHECK mode, if a match is found, the program requests that you enter a value for the delete indicator. Normally, you use the CHECK function while reading through a maga-

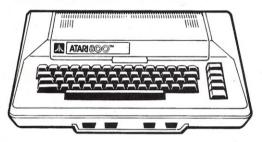
```
1300GOT01220
131011=I\PRINTCHR$(12)\PRINT"HIT ON ",C$,X
1322PRINT"INPUT 99 TO MARK FOR DELETE"
1330INPUT X\IFX=00RX=99THEN1350
1340GOT01310
1350GOSUB1500
1355Z9=1
1360L$=CHR$(48)+"DATA"+STR$(N)+","+CHR$(49)+","+STR$(Z9)
1370Z=FNL(L$)\L$="RUN"\Z=FNL(L$)
1 390STOP
1400RFM
1430DEFFNL(L$)
1436L$=L$+CHR$(13)
1440FORI=1TOLEN(L$)
1445 A$=MID$(L$, I, I)
14500UTO, ASC(A$)
1460NEXT
1470RETURNO
1480FNEND
1495REM
1500L$=STR$(I1)+"DATA"+CHR$(34)+C$+CHR$(34)+","+STR$(X)
1510Z=FNL(L$)
1520RETURN
3000REM
3010X=0\11=N
3020PRINT"ENTER NEW REQUEST/RETURN ... HIT RETURN TO EXIT"
3030PRINT"
3035INPUTC$
30401FC$=""THEN1100
3050I1=I1+1\Z9=1
3060GOSUB1500
3070L$=CHR$(48)+"DATA"+STR$(I1)+","+CHR$(50)+","+STR$(Z9)
3080Z=FNL(L$) \L$="RUN" \Z=FNL(L$)
3090GOT01390
4000REM
401 OR FM
4020PRINT"....WORKING"
4022RESTORE1
4030D=0
4035FORI=1TON
4038READC$, X
40401FX=99THEND=D+1
4042NEXT
4045IFD=OTHEN4300
4050GOSUB4060
4055GOT04090
4060PRINT"THERE ARE ",D," DELETIONS"
4070INPUT"SHOULD I CONTINUE (Y OR N) ?", T$\RETURN
4090IFT$="Y"THEN4100ELSE1100
41 OORESTORE1
4110FORI=1TON\READX$, V\NEXT
41 20RESTORE1
41 30FOR I=1TON\READC$, X
41 331FX=99THENEXIT41 50
41 40NEXT
41 50PRINT"
              ",C$,X," BEING DELETED"
4160INPUT"HIT RETURN TO CONTINUE", T$
4170L$=STR$(I)+"DATA"+CHR$(34)+X$+CHR$(34)+","+STR$(V)
4180Z=FNL(L\$)\L\$=STR\$(N)\Z=FNL(L\$)
41 90Z=N-1 \Z9=1
4200L$=CHR$(48)+"DATA"+STR$(Z)+","+CHR$(51)+","+STR$(Z9)
4210Z=FNL(L$)\L$="RUN"\Z=FNL(L$)\GOTO1390
4300L$=CHR$(48)+"DATA"+STR$(N)+","+CHR$(48)+","+STR$(Z9)
4310Z=FNL(L$)\L$="RUN"\Z=FNL(L$)\GOTO1390
5000RFM
501 ORESTORE2\PRINTCHR$(12)
5020L=0
5030FOR T=2 TO N
5040READC$, X
5045N1=I-1
5050PRINT N1, TAB(5), C$, TAB(35), X
5060L=L+1\IF L>13 THEN GOSUB5500
5070NEXT
5080PRINT\INPUT"RETURN TO CONTINUE",T$\GOTO1100
5500PRINT\INPUT"RETURN TO CONT - X TO ABORT", T$
5510IFT$="X"THEN1100
5520PRINTCHR$(12)\L=0\RETURN
12000REM
12005IFZ9=1THEN13000
1201 OL$="ODATA"+STR$(N)+","+CHR$(48)+","+STR$(Z9)\Z=FNL(L$)
12020L$="PRINT FREE(0)"\Z=FNL(L$)
12030L$="BYE"\Z=FNL(L$)
12050STOP
13000Z9=0
13010L$="0DATA"+STR$(N)+","+CHR$(48)+","+STR$(Z9)\Z=FNL(L$)
1 301 2L$="EXEC"\Z=FNL(L$)\L$="<2>LIT-R-COM"\Z=FNL(L$)
13040STOP
```

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zine. When an advertisement strikes your eve, you check to determine if a request was made previously of that company for information. If a match is found, just enter a 0, hit return, and the program will continue. If no match is found, then go to the ADD function. When the literature requested arrives, use the CHECK function to get you to the proper record. Set the delete indicator to 99, and when you next use the DELETE function. the record will go away.

The last function is DELETE. Only records with a delete indicator of 99 can be deleted. The program cycles through all DATA statements and counts the number of records to delete. Two checks are built into the program to prevent erroneous deletions. First, after counting, the program requests, "Should I

the END OF JOB routine. Because all the information is a part of the BASIC program, you must save the program when you are finished with it or you will lose all the updates. An end of job indicator is built into the program and is part of DATA statement 0. If a record is added, deleted or modified, this indicator sets to 1 from its normal state of 0. At end of job, if the indicator is a 0, the program displays the number of free bytes left and returns to the Poly executive. If the indicator is 1, then the program must be saved.

I utilize another nice Poly feature-invoking a separate command file to compress my diskette, save the updated version of this program, delete the old version, rename the new one and compress the diskette

; COMMAND FILE FOR LITERATURE-REQUEST PACK 2 CONTINUE SAVEF: <2>LIT-R-TEMP.BS EXEC DEL <2>LITERATURE-REQUEST.BS <2>LIT-R-TEMP.BS <2>LITERATURE-REQUEST.BS ZAP PACK 2 <2>LITERATURE-REQUEST

Example 2. Command file.

continue?" Any answer other than yes will exit the DELETE function and return to the selection screen. Second, when the specific record is about to be deleted, it is displayed on the screen. A carriage return is necessary to continue the process. This double loop continues until all records with a 99 are eliminated.

Deleted records are not really deleted. If they were, empty spaces would remain in the DATA statements, which would need manual intervention to compress. Rather, a deleted record is replaced by the last DATA statement (its statement number is changed to that of the deleted record), and the last DATA statement number is eliminated. This leaves all the DATA statements compressed at the front of the program.

The last item for discussion is

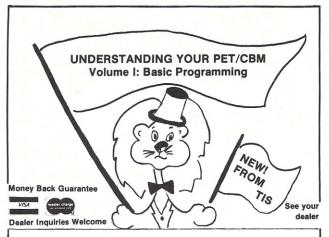
again. Example 2 shows a copy of my command file.

Conversion to Other BASICs

Most of the program uses standard BASIC commands. The key to conversion to another BASIC is the ability to internally create and output the DATA statements. If you have disks, then the data file can be maintained there.

Conclusion

This program helps to maintain a small data base of information. The possibility exists to use many different codes (besides 0 and 99) in the delete indicator for many different meanings. I have already used this program to handle two different unrelated applications. The program can handle any application that requires maintenance of a list.



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Questions and Answers On Memory Devices

Part 2 of this series continues with more answers to computerists' questions.

David Price 3901 Victoria Lane Midlothian, VA 23113

e've come a long way since the days when computer memories were made of relays or vacuum tubes. In this day of rapid inflation, modern memories seem almost anachronistic: every year they become cheaper, faster and more compact. At the same time, memory purchasers are acquiring greater freedom of choice as the market becomes more diverse. But this broader range of products can be a two-edged sword for the newcomer: each new device added to the bushel makes it more difficult to become well informed about the many selections within the bushel.

Some distinctions between product types are pointless and erudite. But there are still many things that the typical newcomer wants to understand. Most of us-when we were tyros ourselves-started by latching onto one of the cognoscenti and asking lots of questions. Others -perhaps inhibited by pride or shame, or both-avoided asking direct questions and took the book or magazine route instead. Maybe you did both. In whatever case, you were hunting for answers to a constant flow of enigmas. We'll start with something simple-just as you

Q: Why are there so many different types of memories? Since

they all do the same thing, why is there more than one kind?

A: They don't all do the same thing. All computer memories have the same basic function—to store information—but beyond that, there are considerable variations.

The most elementary distinction is between main memory and mass storage. Main memory usually contains the program instructions and data associated with the task that the system is currently handling. Mass storage ordinarily contains programs and data on a long-term basis.

Main memories of contemporary computers (both micro and mini) use *semiconductor* devices. For microcomputers, the most common mass-storage devices are *disk drives* and *tape drives*; in fact, many systems use both. Other types of memory devices are available, too. For now we'll call them *miscellaneous*.

Q: That makes four categories altogether. Should we go through them individually?

A: Agreed.

Magnetic Tape Cassettes

Q: Are the tape cassettes used in microcomputer tape drives the same as those I use for my cassette deck?

A: More or less. In some cases it's best to use special cassettes that are certified for high-density recording. But most hobbyists use standard audio cassettes.

Q: How does the drive itself dif-

fer from ordinary tape recorders?

A: Sometimes it doesn't. Often, the drive will actually be a consumer-grade audio recorder adapted for microcomputer use. With most systems, the quality of the drive isn't as important as the reliability of the tape.

Other systems use more advanced drives that can be controlled by electronic commands from the computer. This feature allows the computer direct control of the drive functions.

Q: How can digital information be recorded with audio equipment?

A: An electronic interfacing device between the computer and the tape drive converts the computer output into audio signals. The interface also decodes audio output from the drive and transmits the results to the computer. Thus, the drive can be used both to store and to retrieve information.

Among microcomputers, the most common coding format is the Kansas City Standard, devised in November 1975 by a conference of microcomputer manufacturers. Since there were (and are) many incompatible formats in use, the standard was welcomed because it provided a basis for common interchange of cassettes among users of different equipment.

Q: What are the primary advantages and disadvantages of cassette storage?

A: Compared with disk drives, tape devices sacrifice speed in exchange for economy. Cassette recorders are inexpensive, but their usefulness is limited to sequential storage. That is, they can store and retrieve only continuous blocks of data; they cannot access a specific datum except with great difficulty. For instance, if a cassette had 100 numbers stored on it, the tape drive could easily read them all in sequence. It could not, however, zero in on the 53rd number without passing over the first 52. As we'll see in a moment, a disk drive can zero in on one item; this is called random access (as opposed to sequential access).

Aside from the limitation of sequential storage, the performance of cassette systems is further hindered by their low data-transfer rate. While a slow disk system can read or write data at upwards of 10,000 characters per second, the fastest audio cassette interfaces transfer data at only a few hundred characters per second. Most cassette systems are even slower.

Disks

Q: What is a floppy disk?

A: A floppy disk, or diskette, is the storage medium upon which floppy-disk drives write data and from which they read it. If you could stretch a piece of audio tape like Silly Putty into a disk of a little less than eight inches in diameter, you would have the innards for an 8 inch diskette. Diskettes use the same magnetically sensitive oxide coating as cassettes. The oxide goes on a

heavy Mylar backing, which, after a number of holes have been punched into it, is, in turn. sealed inside a plastic jacket. The jacket helps protect the oxide surface from dust and other contaminants.

Q: How much data can one disk hold?

A: That depends on its size and its format. Eight inch disks that follow the popular IBM 3740 format can hold about 256,256 characters. Smaller disks, 51/4 inches square, commonly hold about 90K.

Many disk systems have provisions for dual-density storage, which allows twice as much data to be crammed into the same disk space. Another technique to increase disk capacity is the use of double-sided drives and media. A double-sided disk has oxide on both sides of the Mylar; a double-sided drive has a separate read/write mechanism for each side of the disk. This, too, allows twice the normal data capacity. Use of both dual-density formatting and double-sided drives would, naturally, yield quadruple capacity.

In discussions of disk capacity, you must remember whether you are referring to formatted or unformatted capacity. Since a substantial amount of space throughout the disk is allocated to system-related functions such as identification and control, the capacity available for storage of user data is actually far less than the total disk capacity. The formatted capacity is simply that left over for storage of user data after the overhead disk space is subtracted. The unformatted capacity of a 3740-type disk is around 382,000 bytes, for example, leaving a formatted capacity of 256,256 bytes.

Q: How is data organized on a disk?

A: The disk is first divided into concentric rings called tracks. Each track is then sliced like a pie into sectors. The disk is not divided physically, of course; these terms merely describe the pattern in which data is stored on the disk surface.

Q: How many tracks does one disk have, and how many sectors does one track have?

A: That, too, depends on the format involved. An 8-inch 3740-format disk is divided into 77 tracks. Each track has 26 sectors. Each sector can hold 128 data bytes. The formatted capacity is, therefore, $77 \times 26 \times 128$, or 256,256. The outermost track is number 0, while the centermost track is number 76.

Q: Number 0? Most people start counting with one, not zero. Why do computer types do it differently?

A: Because . . . well, just because.

Q: Oh, well. What diskette formats are there besides 3740?

A: There are quite a few, actually. One format often used with 51/4 inch minidisks uses 35 tracks, 10 sectors per track, and 256 data bytes per sector—for a total of 89,600 bytes. There exists a more densely packed minidisk format that uses 77 tracks, 16 sectors and 256 bytes per sector-for a total of 315,392 bytes. As you can see,

there's a lot of variation.

And there is yet another point of variation to consider: the sectoring method. Some disk formats use hard sectoring; some use soft sectoring. This distinction involves variation in the construction of the disk itself.

All floppy disks have a hole punched near the outer edge of the Mylar disk. It is called the index hole, whose purpose is to mark revolutions of the disk. Disk drives have sensors that can detect the index hole. When the index hole is detected, the drive controller knows that the sector following the index hole will be sector number zero. The difference between hard sectoring and soft sectoring is this: hard-sectored disks will have, in addition to the one index hole, a sector hole behind every sector; soft-sectored disks have only the index hole. Thus, a hard-sectored disk formatted for ten sectors/track will have eleven holes-one index hole and ten

sector holes-punched along its outer edge.

Q: Hard sectoring sounds more complex. What is the advantage?

A: Soft-sectored formats must allocate more disk space to overhead, because the absence of a hole to mark each sector means that the sectors must be marked off and identified by information recorded on the disk itself. As a result, soft sectoring reduces the formatted capacity of the disk.

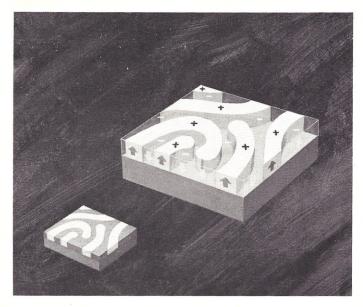
Q: What are the hardware elements that comprise a disk storage subsystem?

A: The hardware can be divided into two sections: the drive and the controller. The drive includes the mechanical functions, such as the read/write head, a 360 rpm motor to spin the disk within its jacket, a positioner that places the read/write head over the desired track and a photosensor that detects the index hole and the sector holes

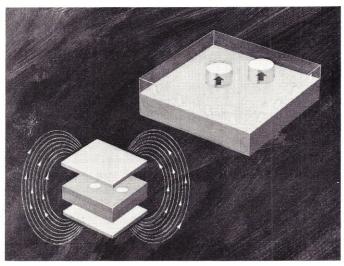


A floppy disk subsystem including drives, controller board and diskettes.

(Courtesy Micropolis Corp.)



A peek inside a bubble memory. Thin films of certain magnetic materials, such as synthetic garnet, contain randomly shaped domains. (Photos courtesy of Rockwell International)



When a magnetic bias field is applied in a direction perpendicular to the thin film by two permanent magnets placed on either side of the device, these randomly shaped domains shrink into bubbles. The bubbles are cylindrical magnetic domains of fixed volume whose polarization is opposite that of the thin film.

(if any). The controller includes the electronic functions that accept commands from the host computer and translate the commands into instructions that the drive can understand. Some controllers are smarter than others. The smarter the controller, the less work there is for the host computer. Given only the file name, some controllers can retrieve data files, while other controllers have to be told the exact location of the file by track and sector. A few controllers even have their own onboard microprocessors. (Most,

however, use high-density integrated circuits designed specifically for the task of controlling a disk drive.)

Q: What about software?

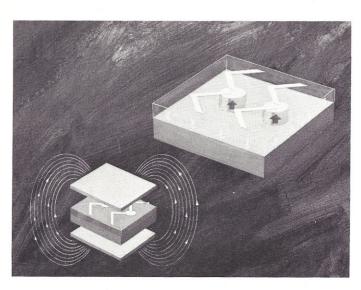
A: The systems software that directly controls drive operations is called the *driver*, which is usually part of a larger program or program series called an *operating system*. (Sometimes the abbreviation *DOS*, which stands for disk operating system, is used instead.) Whenever the operating system has dirty work to be done, it passes control to the driver. Just as the

controller translates instructions for the drive unit, the driver is similarly responsible for spoon-feeding the controller, and the operating system translates user commands for the driver.

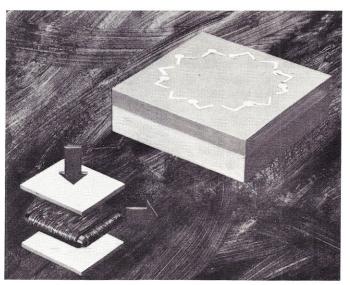
A bit of overlapping crops up here and there, but the scheme is basically very specialized. And, paradoxically, this specialization allows a good deal of generality in the hardware-software interface. For example, if we had an operating system running on drive "Brand A," and we wanted to use it on "Brand B,"

we could adapt the entire operating system for the new drive by changing only the driver. The CP/M operating system has become widespread with the help of this approach. The licensee (say, a drive manufacturer) who wants to convert the CP/M operating system to run on his equipment merely modifies a subprogram called BDOS (Basic Disk Operating System). BDOS is, among other things, the driver portion of CP/M.

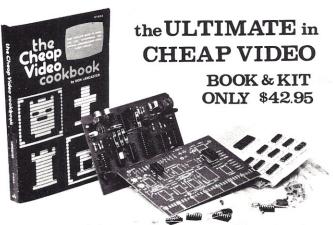
Q: How does an operating system know where to look for a



To guide the movement of the bubbles, a permalloy pattern of chevrons is applied to the surface of the film to form paths. The permalloy paths are formed as loops. The presence of a bubble in a certain position on the loop represents a 1 bit; the absence, a 0 bit.



When, in addition to the magnetic bias field, a rotating magnetic drive field in the plane of the film is applied by a pair of permanent coils, the bubbles move extremely rapidly along the paths.



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given data file?

A: It maintains a directory of files and file locations (by track and sector) on the disk itself.

Q: What if the operating system accidently mangles the directory?

A: Life is like that sometimes. That's why prudent people keep backup copies of important disks.

Q: Are other types of disk storage besides floppy disks available?

A: There are several, but only one has been adopted for microcomputer use: the Winchester design, which differs from floppy drives. First, the disk cannot be removed; it is fixed and sealed within the drive. Second, the disk is typically based on aluminum rather than Mylar; this type of storage therefore has the nickname hard disk (as opposed to floppy disk). Third, the read/write head does not touch the disk surface. Unlike the contact-head approach of floppies, Winchesters use a flying head that floats aerodynamically above the disk. The gap between the flying head and the disk is very small, of course, but the absence of direct contact

eliminates disk surface wear. Because the disk is protected from both head friction and atmospheric contamination, Winchester drives can also use far greater rotation speeds. The result: faster access and higher capacity. Winchesters are presently available in 8-inch and 14-inch versions with capacities of 10 megabytes (i.e., 10 million characters) and up.

Semiconductors

Q: Why are semiconductor devices used as main memory, while diskettes and cassettes are used as mass storage?

A: Semiconductor memories are faster and more expensive. They are, consequently, well suited for main memories but are too costly for bulk use as mass storage.

Q: How fast are semiconductor memories?

A: Their access times are usually measured in nanoseconds. A nanosecond is a billionth of a second. (A beam of light—no slowpoke by anyone's standards—can travel less than one foot in a nanosecond.)

Speedy semiconductor chips such as the Intel 2125H can



A completed bubble memory device photographed on a magnified portion of the chip's circuitry.

cough up a datum in 20 nanoseconds. Most microcomputers, however, use chips in the 200-500 ns range.

Q: What is the difference between programmable memory and read-only memory?

A: Programmable memories can be both read and written. Readonly memories are preprogrammed; the processor cannot directly change their contents.

Q: Read-only memories sound less versatile.

A: They are intended for situations where programmable memories (or RAMs, as they are sometimes called) would be impractical. For example, contemporary RAMs lose their contents when their operating power is interrupted. Thus, whenever a power outage occurs, or whenever the system is turned off, the system must somehow reload all RAM with the desired contents upon power-up. With readonly memory the data is frozen in place and does not need to be reloaded.

Q: How are read-only memories programmed?

A: Different types are programmed in different ways. Mask ROMs, for example, are programmed by the manufacturer. This is economically practical only when you buy a large number (500–1000+) of identical chips at once.

Other types are programmed by the user. The user is then said to be *burning* the device. Since many poeple do not have the equipment needed to burn their own memories, some chip suppliers offer programming services to their customers.

Read-only memories that can be burned only once are called PROMs (programmable read only memory). Some, however, can be erased and reprogrammed. EPROMs (erasable PROM) are erased with ultraviolet light, while EE-PROMs (electrically erasable PROM) can be erased under processor control with electric current.

Q: What is the difference between static and dynamic RAM?

A: Dynamic RAM requires that the system provide periodic electronic signals called *refresh pulses*. Previously, the refresh requirements of dynamic RAM interfered with other functions of the host system. Contemporary designs, however, use *invisible refresh*; that is, they refresh the memories without letting the rest of the system know what's going on. Memory boards designed this way are sometimes called *pseudo static*.

Q: What is the capacity of a single memory chip?

A: Anything you want. You can buy them in nearly any capacity and in any organization. They are specified in terms of pK \times q, where p is the depth in units of 1024 bits and q is the width in bits. A 4K \times 1 chip, for example, has a total capacity of (4 \times 1024) \times 1, or 4096 bits. A 2K \times 2 chip, although arranged differently, is the same size: (2 \times 1024) \times 2.

The depth of a chip is the number of addresses it can recognize. The width is the number of bits it outputs upon receipt of a valid address. Thus, a $4K \times 1$ chip accepts 0 through 4095 as addresses, returning one bit on command. Eight such chips operating in parallel would form a $4K \times 8$ array. This array would have a capacity of 4K bytes, or 4096 characters. Four such arrays could be integrated to form a $16K \times 8$ memory board.

Q: How much memory can a microcomputer address?

A: Most are restricted to 64K (65,536 bytes) of directly addressable memory. A technique called bank switching is available on some systems as a makeshift way to extend the maximum address space. A system allowing up to eight banks of 64K, for example, could address 512K of main memory.

Q: Can memories make mistakes?

A: All man-made devices have small factory-installed gremlins whose favorite recreation is to make their respective devices fail. We cannot banish the gremlins entirely, but we can use many techniques to mitigate their effects.

One such technique is *parity* checking, which can determine whether a byte is incorrect, but it cannot correct the error. A more complex approach, ECC

(error checking and correction), is based on principles developed by mathematician R. W. Hamming. Unlike parity checking, ECC can consistently detect multibit errors. It can also correct single-bit errors.

Other Memories

Q: What are bubble memories used for?

A: Bubble memories are a compromise in performance between semiconductor and disk memories. They have recently become commercially available.

The bubbles are microscopic magnetic regions that move about inside a thin film. They move synchronously along predetermined tracks so that the chip appears to be a mammoth circular shift register. Current bubble memory chips range in capacity from 92K × 1 (Texas Instruments TIB-100) to 1M imes 1 (Intel im7110).

Bubbles have advantages over both semiconductor and disk. Not only are they denser than RAMs, but they are also nonvolatile; that is, they retain

their contents even when operating power is removed. In comparison with disk drives, bubbles need less maintenance and protection from contamination, because they have no mechanical moving parts.

Q: Why are core memories no longer in widespread use?

A: They are simply uneconomical. Semiconductor RAM is cheaper and more compact.

Core memories are made of thousands of tiny donuts strung together on crisscrossing wires. The donuts, called cores, are made of ferrite or lithium. Interestingly, core memories share several characteristics of bubble memories: they are nonvolatile, slow and require extensive support circuitry.

Q: Are there many other types of microcomputer memory that I ought to know about?

A: Not at the moment, no. But technology is moving fast; tomorrow will doubtlessly bring memories that are cheaper, faster and more compact than ever. Be sure to keep yourself posted.



A silicon wafer. The chip on the model's fingertip is similar to those used in semiconductor memory parts.

(Courtesy Rockwell International)

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The Comprint 912 is among the least expensive printers, listing at \$660, but probably available for less. It is fast – 225 characters per second – yet its

print quality is surprisingly good because the letters are formed from a 9×12 dot matrix, which gives superior definition to letters. (See the review of this printer in the March 1980 issue of *Microcomputing*.)

At about \$100, Muse's Super-Text was double the price of their Dr. Memory word processor, but because it furnished so many more controls, it was easily worth the difference. The single and double keystrokes are easy to remember because the letters usually stand for what commands do (e.g., "b" means go to bottom screen, "t" means go to top screen).

Super-Text has standard screen features: insert and delete characters; shift incomplete words at the end of a line to the next line; move cursor all over screen; scroll up or down, a line or page at a time, to beginning or end of text, or to the position of the last change made. But Super-Text also has three unique features.

You can split the screen into two parts, and even vary the screen sizes. This allows you to keep notes or instructions on one screen while editing on the other. You can compare the old sentence with the newly edited sentence or you can look something up in one part of the file while working in another.

Super-Text has a built-in math module that furnishes automatic totaling of columns and computation of formulae. You can select the number of decimal places, from 0 to 9. Super-Text switches to scientific notation when necessary and has 14 significant digits.

A feature called Autolink allows you to connect an unlimited number of files when printing or when searching or searching and replacing. For instance, say you had two files of names, addresses and phone numbers called "LIST1" and "LIST2," and you wanted to find a phone number that might be in either file. Through Autolink you'd load the first file and do a "find." Super-Text would search both files, if necessary, until the desired information was found. This also works with multiple disk drives, so you can imagine Super-Text searching for information through dozens of files on each of several disks.

There are other features you'll appreciate as you work with

Super-Text, such as the option of printing the word "the" with one keystroke. This is a time-saver because the word appears so frequently. The search-and-replace feature is also a time-saver because it allows you to type a short abbreviation for a long phrase that occurs often in your text, then replace the abbreviation with the full phrase.

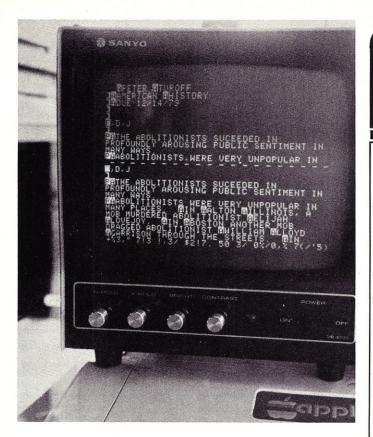
Another nice feature is loading files by number so you don't have to type in a long file title, which may be mistaken or misspelled, resulting in a file-not-found message. Other features are tabbing and right- or left-justification of columnar numbers or text, block moves, multiple copies, numbering and centering.

Combining the Comprint 912 with the Muse's Super-Text resulted in a cost-effective under-\$800 limited, "semi-automatic" typewriting system. I'm balancing low cost, quick listing ability and fairly good print quality vs some limitations in printing capability and quality. The quality is good, but it cannot equal that of Diablos or Qumes. However, these machines cost five times as much as the Comprint 912 and type at one-fourth the speed. It's not easy to do envelopes, forms or a large mailing, but the 912 is capable of producing letters, reports, memos, birthday cards, birth announcements, game rules, recipes and personal finance reports.

The structured Applesoft data-base management system



The system, set up and working.



Note Super-Text split screen on monitor.

called File Cabinet, available from the Apple Software Bank, allows you to set up your record structure with as many or as few fields as you wish. You can sort, add or delete records. Also, you can set up a format to print portions of the data in a variety of forms. It can total columns of figures, both horizontally and vertically. With the aid of the printer, I listed the program and found that it was not too hard to modify to incorporate improvements or custom commands.

The active user group A.P.P.L.E. has an improved version with a faster sort routine, among other improvements. I use it to analyze my financial expenditures and as a name/address/phone/birthday/anniversary file; I plan to use it for a disk-program master catalog. In my opinion, File Cabinet is one of the finer data-base-management programs available at present.

Overcoming Problems

Although my Comprint 912 tested OK, it would not print anything that came from the

computer. After a call to the factory, I decided to ship everything back. Within ten days the printer went coast to coast, was fixed and returned. The trouble was in the wiring of the parallel interface card, the fault of my local computer store (by the way, Comprint 912s now come with a triple interface for Apple-, TRS-80- or Centronics-compatible connections.

At the factory the Comprint people noticed that the paper occasionally wrinkled and discovered a faulty paper-advancing roller. They replaced it, rewired my interface and returned it all.

My joy was curtailed when I ran through the 100 feet of paper supplied with the printer in about 3.14 days, and further curtailed when I learned that the local computer stores did not yet carry paper. I finally obtained paper through the recommended paper factory.

In spite of minimal problems, these three components give me hard-copy output of program listings, letters, articles, reports and records. I am pleased with the system.

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Matrix Sorting

Don't get stuck with "single sorting." Use this technique for multiple data sorts.

A few articles have been written lately on sorting. As any programmer knows, sooner or later you will need to sort some data. But, alas, all the sort programs presented so far deal with sorting only one array.

What if you have more than one type of data—all related—that must be sorted? What do you do? Sort the one array and do the same swaps on all the other arrays as you do on the first? No. You use a matrix sorting subroutine!

The matrix sorting subroutine in Level II TRS-80 BASIC is generalized for sorting two-dimensional arrays by columns or rows. This subroutine employs two versatile techniques used by many programmers, especially technical programmers: matrix storage of data and secondary indexes.

A Case in Point

Before getting into the subroutine itself, let's look at two examples that will illustrate the benefits available from matrix sorting. The first example is an actual case, though greatly simplified for ease of presentation, of a regional sales manager who was responsible for the operation of four stores in his region. To help him in his job he wrote a program to handle the calculation of the profit and loss statement for each store.

He had his data stored in a number of arrays by store-number sequence. There was an array for sales and an another array for expenses. (Actually, there were over 50 separate items collected this way for twelve stores.) All references to store number were by hard coding, that is, if the first item in the array was being processed and printed, the program would print the store number by executing the following statement: IF I=1 THEN PRINT "1254";.

Naturally, coding such as this greatly increased the length of

the program. You really cannot fault this program design, though, because it did work. However, the regions were just reorganized, and two of the stores in his region were now in a new region. He also now had responsibility for two new stores. Not only did he have to become acquainted with two new stores, but he had to change his program references from the old store numbers to the new store numbers.

Required changes such as this are not at all uncommon when you do excessive hard coding rather than designing your program to be table driven. This store manager also had another problem with his existing profit and loss program: he was limited to one form of presenta-

tion and had to do extensive reprogramming to alter the report in any way.

The second example concerns a local retired businessman and his attempts to keep track of his stock portfolio. His program was much like the regional sales manager's. There was a lot of hard coding of data and little flexibility in reporting. He had the ability to print the report in alphabetical sequence (the way his data was stored) or in current dividend yield sequence.

The sort subroutine for sorting by dividend yield had the data swapped in all arrays, along with the array of dividend yields. Once sorted, though, the data was no longer in alphabetical sequence.

	Secondary Index	Array to be sorted
First pass	<u>1</u> <u>2</u> 3 4	21 13 11 18 swap
	2 1 3 4	21 13 11 18 swap
	2 3 <u>1</u> <u>4</u>	21 13 11 18 swap
Second pass	<u>23</u> 41	21 13 11 18 swap
	3 <u>2 4</u> 1	21 13 11 18
Third pass	<u>3 2</u> 4 1	21 13 11 18
final	3241	21 13 11 18

Variable	Subroutine Information Flow	Description
N	input	number of items to be sorted
A(,)	input	two dimensional array,
		one dimension of which
		is to be sorted
S()	output	subscript array
		(secondary indexes)
RC	input	control switch
		1 row sort
		2 column sort
1	input	row number to determine
		sort order in column
		sort
J	input	column number to determine
		sort order in row sort
Ш	local	subscript
С	local .	counter
N1	local	remaining items to
		be sorted
X	local	swap variable

The solution in both cases involved organizing the data into a matrix and using the generalized row-column sort subroutine shown in Program A. A simplified version of the program developed for the regional sales manager is shown as Program B. Program C is the program developed for the retired businessman. Both applications use the same subroutine—one for sorting the rows of a matrix, the other for sorting the columns in the matrix.

How It Works

The core of the matrix sort is a modified ripple sort. If very large arrays are being used, the sort technique can easily be changed to one of the tree sorts. There are really only two differences between this sort and a regular modified ripple sort.

First, there are two IF tests, rather than one. The first IF (line 4080) is used when rows are being sorted; the second IF (line 4090) is for column sorting. Only one is used during the sort, but by including both, the sort gains another dimension (literally).

The second difference from a regular modified ripple sort involves the swap and references to the subscripts. The new code is for the secondary index. Rather than using II as the subscript of array A, the IIth value of S is used. Thus, the swap does not move any data in matrix A but does move the subscripts stored in S. The stock portfolio program (Program C) has an additional test included for alphabetizing the stocks (line 4095).

```
10 REM EXAMPLE OF GENERAL COLUMN SORT
20 CLS
30 DIM A(4, 10), 5(4)
40 REM STORE #, SALES, EXPENSES
50 DATA 1254,
                  8792.
                         6519
60 DATA 2871,
                  7641,
                         6249
70 DATA 5942,
                  8532,
80 DATA 4280,
                  6998,
                         492B
90 FOR J=1 TO N
100 FOR I=1 TO 3
       READ A(I, J)
    NEXT I
130 NEXT J
140 REM CALCULATE INCOME
150 FOR J=1 TO N
      A(4, J)=A(2, J)-A(3, J)
170 NEXT J
180 PRINT "UNSORTED REPORT"
190 PRINT
200 FOR I=1 TO N
    S(I)=I
220 NEXT I
230 GOSUB 1000
240 PRINT:PRINT:PRINT
250 PRINT "SORTED ON STORE NUMBER"
260 PRINT
270 RC=2
290 N=4
300 GOSUB 4000
310 GOSUB 1000
320 PRINT:PRINT:PRINT
330 PRINT "SORTED ON SALES"
340 PRINT
350 REM RC & N STILL SET FROM ABOVE
360 I=2
370 GOSUB 4000
380 GOSUB 1000
390 PRINT:PRINT:PRINT
400 PRINT "SORTED ON EXPENSES"
410 PRINT
420 REM RC & N STILL SET FROM ABOVE
430 I=3
440 GOSUB 4000
450 GOSUB 1000
```

```
479 PRINT "SORTED ON INCOME"
480 PRINT
490 REM RC & N STILL SET FROM ABOVE
510 GOSUB 4000
520 GOSUB 1000
530 END
1000 REM PRINT REPORT
1010 PRINT "STORE NUMBER";
1020 I=1
1030 GOSUB 2000
1040 PRINT
           "SALES":
1050 PRINT
1060 I=2
1070 GOSUB 2000
1080 PRINT "EXPENSES";
1090 I=3
1100 GOSUB 2000
1110 PRINT
1120 PRINT "INCOME";
1130 I=4
1140 GOSUB 2000
1150 RETURN
2000 REM PRINT REPORT LINE FROM A(L,S(J))
2010 FOR J=1 TO N
2020
      PRINT TAB(11*J+2) A(I,S(J));
2030 NEXT J
2040 PRINT
2050 RETURN
4000 REM GENERALIZED ROW-COLUMN MATRIX SORT
4010 FOR II=1 TO N
      S(II)=II
4020
4030 NEXT II
4040 N1=N
4050 C=0:N1=N1-1
4060 IF N1=0 THEN 4160
4070 FOR II=1 TO N1
       IF(RC=1)AND(A(S(II), J)(=A(S(II+1), J)) THEN 4148
4090
       IF(RC=2)AND(A(I,S(II))(=A(I,S(II+1))) THEN 4140
4100
       X=S(II)
4110
       S(II)=S(II+1)
4120
       S(II+1)=X
4130
      0=1
4140 NEXT II
4150 IF C>0 THEN 4050
4160 RETURN
```

Program B. Column sort.

The subscripts in S can then be used for ordering matrix A as well as the array of stock

460 PRINT:PRINT:PRINT

An additional benefit in using secondary indexes is the reduction in the amount of data to be swapped; the original data is not moved. Table 1 shows a simple example of how a secondary index is used. Table 2 lists the variables referenced in the matrix sort subroutine and how they are used.

Program B also shows an additional benefit of using matrixes to hold program data: generalized output subroutines. To print any report, the same subroutine is used (lines 1000-1150). To print any row in any report, another subroutine

```
4000 REM GENERALIZED ROW-COLUMN MATRIX SORT
4010 FOR II=1 TO N
      5(11)=11
4030 NEXT II
4040 N1=N
4050 C=0:N1=N1-1
4060 IF N1=0 THEN 4160
4070 FOR II=1 TO N1
      IF(RC=1)AND(A(S(II), J)(=A(S(II+1), J)) THEN 4140
4080
      IF(RC=2)AND(R(I,S(II))(=R(I,S(II+1))) THEN 4140
      X=S(II)
4100
      S(II)=S(II+1)
4119
4120
      S(II+1)=X
4140 NEXT II
4150 IF COR THEN 4050
```

Program A. General row-column matrix sort.

Program C. Row sort.

```
10 REM EXAMPLE OF GENERAL ROW SORT
20 CLS:DIM A(100,8), S(100), DC(8), DF(4), SN$(100)
30 N=10
40 REM STOCK NAME,
50 DATA CITCO,
                          PRICE, DIV, E/S, SHAF
62.75, 3.2, 12.07, 500
                                                SHARES
                          57. 875, 2. 4, 1. 66,
60 DATA XEROX.
70 DATA DEERE,
                          35. 375, 1. 6, 2. 74, 1000
                                          . 72, 20
80 DATA WARNER-LAMBERT, 24.
                                  1. 2,
                          25. 875,
90 DATA K MART,
                                           . 37, 280
                                   . 84,
                          26. 75, 2,
14. 625, 1,
100 DATA TEXACO,
                                         1. 13, 700
110 DATA MURPHY,
                                            6,
                                                100
120 DATA TORO,
                          21. 5,
                                    . 72, 2. 43,
                                                0
130 DATA MONSANTO,
                                   3. 2,
                                          4. 4,
140 DATA FIELDCREST,
                          28. 625, 1. 4,
                                         1. 11,
200 FOR I=1 TO N
210
      READ SN$(I)
      FOR J=1 TO
220
        READ A(I, J)
230
249
      NEXT J
250 NEXT I
260 DATA ########, ######, #, #####, ##, ####. ###
270 FOR I=0 TO 3
280 READ DF$(I)
290 NEXT I
300 DATA 3, 2, 2, 0, 1, 1, 0, 2
310 FOR I=1 TO 8
320
     READ DC(I)
330 NEXT I
340 REM CALCULATIONS
350 FOR I=1 TO N
```

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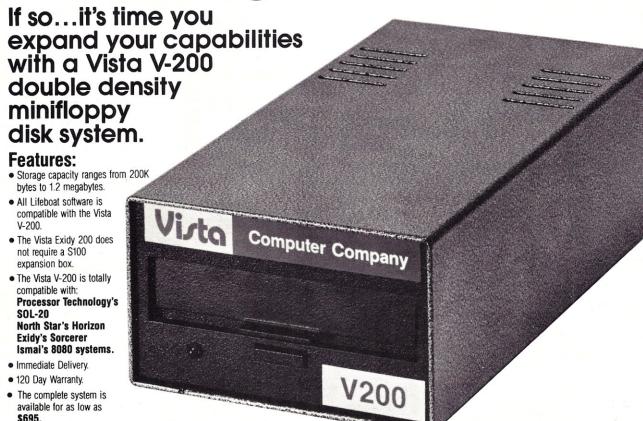
```
REM CALCULATE DIVIDEND RATE OF RETURN A(1,5)
369
379
      A(1,5)=B(1,2)/B(1,1) * 100
      REM CALCULATE PRICE/EARNINGS RATIO
380
      REM CALCULATE MARKET VALUE
                                               B(L,7)
410
      B(1,7)=B(1,1)*B(1,4)
      REM CALCULATE ANNUAL DIVIDEND RECEIVED A(1,8)
429
      A(I,8)=A(I,2)*A(I,4)
440 NEXT I
500 CLS
510 PRINT "ENTER REPORT SORT OPTION"
520 PRINT TAB(10) " 1. NO SORTING"
530 PRINT TAB(10) " 2
                        ALPHARETIZED
540 PRINT TAB(10) "
                     3
                        PRICE RANKING
550 PRINT TAB(10) " 4.
                        DIVIDEND RANKING"
560 PRINT TAB(10) " 5.
                        ERRNING/SHARE RANKING"
                        # OF SHARES OWNED"
570 PRINT TAB(10) "
                     6.
580 PRINT TAB(10) " 7.
                        DIVIDEND RATE OF RETURN"
590 PRINT TAB(10) "
                        PRICE/EARNINGS RATIO"
                     8.
                        MARKET VALUE OF SHARES OWNED"
600 PRINT TAB(10) " 9.
610 PRINT TAB(10) "10. ANNUAL DIVIDEND RECEIVED"
620 PRINT TAB(10) "11. END"
630 PRINT
640 FOR I=1 TO N
650 S(I)=I
669 NEXT I
679 INPUT"ENTER OPTION"; O
680 IF 0()INT(0) THEN 500
690 IF(0(1)0R(0>11) THEN 500
700 IF 0=11 THEN END
710 IF 0=1 THEN 750
720 IF 0=2 THEN RC=3 ELSE RC=1
730 J=0-2
749 GOSUB 4999
750 PRINT
760 INPUT"TURN ON LINE PRINTER AND HIT ENTER"; Z$
770 IF OC3 THEN 780
771 LPRINT TAB(18) " ".
772 FOR I=1 TO 0-2
773 LPRIN
774 NEXT I
     I PRINT
775 LPRINT "*"
780 LPRINT" STOCK";
790 LPRINT TAB(20) "
                        PRICE";
             DIV/SHR";
800 LPRINT"
810 LPRINT"
820 LPRINT"
             SHARES":
830 LPRINT"
              DIVZRET";
840 LPRINT"
850 LPRINT"
              VALUE";
860 LPRINT" TOT DIV"
870 LPRINT '
880 FOR I=1 TO N
890
     LPRINT SN$(S(I));
900
     LPRINT TAB(19)
910
     FOR J=1 TO 8
        LPRINT USING DF$(DC(J)); A(S(I), J);
930
      NEXT I
     LPRINT " "
940
950 NEXT I
960 LPRINT
970 LPRINT
980 LPRINT
990 GOTO 500
4000 REM GENERALIZED ROW-COLUMN MATRIX SORT
4010 FOR II=1 TO N
4030 NEXT II
4040 N1=N
4050 C=0:N1=N1-1
4060 IF N1=0 THEN 4160
4070 FOR II=1 TO N1
       IF(RC=1)AND(R(S(II), J)(=R(S(II+1), J)) THEN 4140
4080
       REM IF(RC=2)AND(A(I,S(II))(=A(I,S(II+1))) THEN 4140
4095
       IF(RC=3)AND(SN$(S(II))(=SN$(S(II+1))) THEN 4140
4100
       X=5(11)
       S(II)=S(II+1)
4110
       S(II+1)=X
4130
      C=1
4140 NEXT II
4150 IF C>0 THEN 4050
4160 RETURN
```

is used (lines 2000-2050). If any report formatting needs to be redone, all the code will be in one place, and the changes can easily be accomplished.

Conclusion

The matrix sort subroutine presented here is easy to use and versatile. When writing your next program, incorporate the matrix sort and use a matrix to hold your data. And don't forget about secondary indexes. Once you get used to using these techniques, you will never go back to your old programming techniques. I never will!

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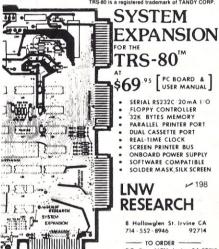
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Disk Divinations

How to build and use a small tester for mini-floppy disk drives.

William Hosking 8626 E. Clarendon Scottsdale, AZ 85251

Since I repair mini-floppy disk drives in my spare time at home, it didn't take me long to realize it was tremendously inconvenient to connect and disconnect from my computer system every time I wanted to check a different drive's functions. I set out to design a small test fixture to test all of the major functions on a standard mini-floppy drive

without the use of a computer. Since the disk drive connections are standardized, the logic and power connect easily and only require one type of plug each.

Design Concept

The primary functional signals to and from a mini-floppy are listed in Table 1. These pinouts have been standardized, at least for Shugart and Wangco (now Siemens). A complete schematic of my test box is shown in Fig. 1.

The incoming signals to the test box from the drive are: write protect (WP), track 0

(TR00), index and read data. They are open collector outputs from the drive and require 150 Ohm terminations to +5 V at the test box. The signals are then fed into a 4049 inverting CMOS buffer, which, in turn, drives LEDs on the panel of the test box. Although both index and read data are pulsed signals, when operating properly, they will provide an adequate indication on the LED.

The outputs from the test box to the drive are almost all switch closures. The drive selects and motor control are active when grounded, so a simple switch closure to ground will do the job. Switch debouncing is not required.

The direction line is on a switch, where the on (ground) position represents step in and the open position is step out. The write gate output is grounded for write enable and open for read enable.

The remaining two outputs from the test fixture are pulses. The step button produces a negative going pulse of approximately 2 microseconds to step the head in whichever direction has been selected by the direction switch.

I have hooked up the second side of the multivibrator as free running to put a series of pulses on the write data input. This will not write anything usable to a disk, but it will provide a digital pulse stream for tracing through the disk write circuitry. As a final touch, I put a BNC jack on the test box to bring out the read data signal for observation on an oscilloscope.

Operation

Utilization of the drive test box makes operational checkout of a mini-floppy disk drive simple. Simply connect power and signal connectors via the appropriate cables, supply power to the test fixture and continue.

Detailed troubleshooting of a drive is beyond the scope of this article; however, I have presented the following steps as a basic guide to using the test fixture. One of the three drive

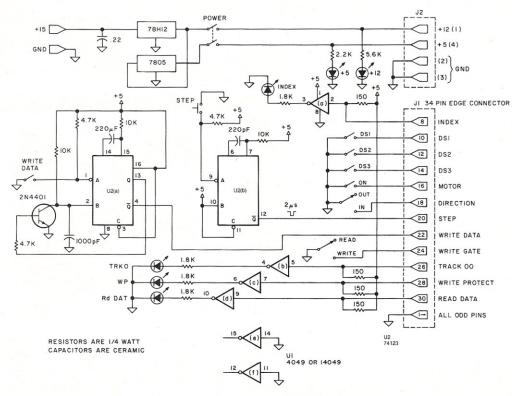
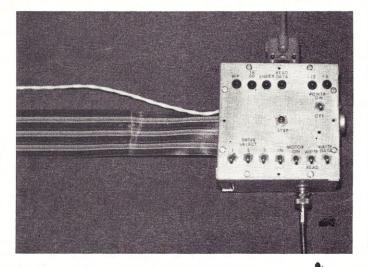


Fig. 1. Schematic diagram of the mini-floppy drive test fixture.



Mini-floppy drive test box.

select lines should cause the drive to activate as indicated by the front panel LED on the disk drive. Once the drive is selected, turning on the motor switch should cause the motor to start.

If a disk had been loaded, the index LED should start flickering, and the read data LED should be on. Additionally, if the disk inserted was write protected (notch taped ever), the WP LED should now be on. If an oscilloscope is connected to the BNC connector on the test fixture, it should show the read data output pulses.

Now observe the sliding read-write head assembly through the side of the drive and momentarily push the step button on the test fixture. The slide should step one position

Pin	Signal	Notes
1-33 odd	ground	
2,4,6	no connection	
8	Index	Output, open collector
10	DS1	Input, ground active
12	DS2	Input, ground active
14	DS3	Input, ground active
16	Motor	Input, ground for on
18	Direction	Input, ground = in, open = out
20	Step	Input, pulse negative
22	Write Data	Input, negative pulses
24	Write Gate	Input, ground = write
26	Track 00	Output, open collector
28	Write Protect	Output, open collector
30	Read Data	Output, open collector
32,34	no connection	

Table 1. 51/4 inch mini-floppy disk drive edge connector signals.

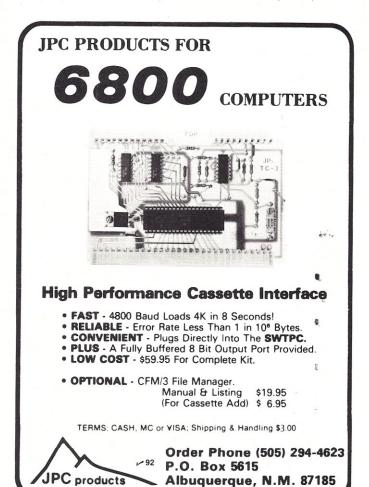
in whatever direction the direction switch is set. Track 0 is the outermost track position. Setting the switch to out and repetitively pushing the step button should cause the head to move out until the track 00 LED, which is the reference point for all disk operations, comes on.

Before putting a non-protected disk in and turning on the write data and write gate, make sure that you don't damage any

data, since it will cause erasure.

Conclusion

This device is convenient for repairing mini-floppies. To finish the package, however, you need schematics for the various models and versions of drives you intend to service. These are usually part of a service manual that can be obtained from a distributor or company rep.



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ART" and "USART" and other combinations of the same letters refer to integrated circuits that are universal, synchronous, and/or asynchronous, receiver/transmitters. Their internal makeup is described by the particular combination of these letters. One manufacturer refers to his device simply as an "SIO" for serial input/output.

No matter how designated, the devices are used for the serial transmission of digital data. The transmitter section takes a byte of data in parallel, appends start and stop bits and a parity bit, if desired, and shifts out the data one bit at a time at one of many standard signaling rates, referred to as the "baud" rate.

The receiver section of the same device is used to gather a stream of serial data bits, strip off the start and stop bits, check the parity of the received data and present it to the receiving device in a parallel format.

With many of the UARTs now on the market you can transmit (Tx) and receive (Rx) at the same time; with some of these ICs, the

Tx and Rx can be at different baud rates at the same time. The Tx and Rx clock inputs to the UART are at 16 times the baud rate (16 x), and it is the clock frequency that determines at what rate the transmitter will shift out the data bits. If the Rx clock is not the proper 16 x frequency, the received data is garbled.

The clock frequency supplied to the UART must be within 5 percent of the correct value for the desired baud rate. The baudrate generators on the market

use a crystal oscillator and digital counters to produce the desired 16 x clock. Their accuracy is well within 1 percent, which is many times the accuracy required.

One disadvantage of the IC baud-rate generators is that they can produce only a single frequency at a time and must be switched from baud rate to baud rate when different signaling rates are desired. In a microcomputer system, it may be desirable to have several UARTs

running simultaneously at different rates.

For instance, in my system I send data to a line printer at 1800 baud, send and receive from an audio tape interface at 600 baud and operate an ASR-33 Teletype at 110 baud. To avoid having to switch baud rates or patch interfaces, each device has its own UART, which simplifies things and reduces operator

A single generator (Fig. 1) produces all the standard 16 x clock

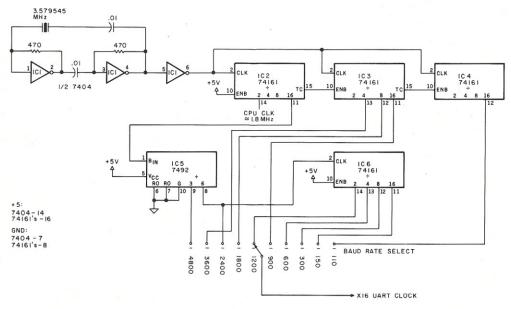


Fig. 1. The "colorful" baud-rate generator divides the output of an oscillator based on the ubiquitous TV color-burst crystal. All of the UART clock rates are available at one time, or a switch can be used to select any one frequency, as shown.

frequencies corresponding to baud rates from 4800 to 110. Although the schematic shows a selector switch to pick off the desired rate, I don't use one in my system since all the clocks are produced simultaneously, and my UARTs are each dedicated to a particular baud rate.

Producing *all* of these rates in a particular system is probably not necessary, so the circuitry shown can be simplified. For example, if you could operate your remote terminal at 3600 baud, and needed only one other rate for a TTY printer (110 baud), you could eliminate IC5 and IC6. Omitting IC3 and IC4 would still produce the binary sequence of rates: 4800, 2400, . . . 150.

The ICs and the crystal chosen for this circuit are all common types available at "jelly bean" prices. The crystal is the TV color-burst frequency, 3.579545 MHz, and is available at prices ranging down to 99 cents. This means the circuit can be built for less than the cost of a dedicated baud-rate generator IC and its special frequency crystal. When completed, this circuit produces all the frequencies at the same time.

You could even tap off 3.579545 or 1.789773 MHz for use as a microprocessor CPU clock, but then those guys running at 4.00 or 2.00 MHz would beat you out in the *Kilobaud* benchmark race (see the June

and October 1977 issues).

Accuracy Considerations

Table 1 lists the baud rates, the desired 16 x clock rates and the actual frequencies produced by this circuit, rounded off to the nearest 1 Hz. The Percent Error column shows that, depending on the path taken through the counters, the clock rates are in error either 0.7 percent or 2.9 percent, all on the low side.

How accurate does your UART clock have to be? Since you can assume that the equipment you are communicating with uses the more accurate baud-rate generators, you can hog almost the entire error budget on your end. Fig. 2 illustrates the allowable error.

The UART detects the leading edge of the start bit, then spaces over one-half of one bit duration and samples the start bit to

Baud Rate	UART Clock	Actual Clock	Percent Error
4800	76800	74574	2.9
3600	57600	55930	0.7
2400	38400	37287	2.9
1800	28800	27965	0.7
1200	19200	18643	2.9
900	14400	13983	0.7
600	9600	9322	2.9
300	4800	4661	2.9
150	2400	2330	2.9
110	1760	1748	0.7
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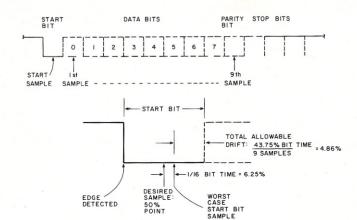


Fig. 2. The "worst case" condition of eight data bits and a parity bit. If the received UART clock rate is in error, the sample point will drift through the bit stream. To insure proper sampling of the last (parity) bit, the clock must be within 4.85 percent of the proper frequency.

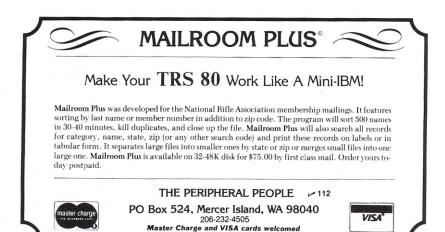
make sure it is still there. Because of this technique, a transient spike would have to be at least one-half bit long to fool the UART. Since we have supplied the UART with a clock at 16 times the bit rate, the most accurately it can position its sample point is $\pm 1/16$ of the bit time, or 6.25 percent. The UART is aiming for the center of the bit time, but can miss the 50 percent point by as much as 6.25 percent. This leaves us an error budget of 43.75 percent of one bit time. All successive samples of the following bits must be taken within this window.

As you can see from Fig. 2a, you have nine more samples to take. Since your colorful clock generator is stable, but not ac-

curate, you have to be sure that your frequency is within 43.75 percent divided by nine samples, or 4.85 percent of the desired value. At a maximum error rate of 2.9 percent, you are safe.

You're not too safe, though, as other factors contribute to errors. Any asymmetry in the circuits that decode and process the serial bit stream before it gets to the UART can cause trouble. In actual practice, the colorful baud-rate generator has proved capable of providing error-free communications through 20 mA current loops, RS-232 paths and the modem used for recording data on audio cassette recorders.

This one generator can run them all at the same time! ■





Beat the MIKBUG Memory Squeeze

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Bill Vodall Box 336 Oilmont, MT 59466

appreciate the convenience of having a power-on monitor such as MIKBUG, but don't believe it is worth the 8K of the memory map required in addition to preventing use of the reset and software interrupt vectors of the 6800. By adding 3 ICs I was able to have MIKBUG and memory too. Now I have a switch on the front panel that will give either MIKBUG from \$E000 through \$FFFF as normal, or in the other position will move a 4K static memory board from \$7000 to \$F000. This gives me memory in the uppermost posi-

AIS AIS

IO, I3

OB

CHIP—OCHIP—OCHIP—ORIVERS

UDI

Fig. 1. CPU mod.

tion of the memory map as well as access to all the 6800 vector addresses.

The Procedure

I used the two user-defined lines on the SWTP bus, but jumper wires could be used. Remember that this involves rerouting an address line and chip enables, so keep everything short and neat.

Step 1: Disconnect pin 8 of IC16 on the SWTP MP-A processor board by either pulling it out of the socket or unsoldering it from the circuit board. Then run a jumper from pin 8 on the board directly down to the pad for UD1. See Fig. 1.

Step 2: Cut the trace from A15 on the Molex connector to pin 4 of IC22 on an MP-M 4K memory board. Run a jumper from the IC22 side of the cut to the UD2 pad. The memory board can only be enabled when UD2 is brought

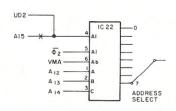


Fig. 2. MP-M.

low. See Fig. 2.

Step 3: Build the circuit of Fig. 3. I used a Seal WireWrap board, but use whatever technique you prefer. Remember—keep everything short. Now whenever the select line is high (a plus 5) everything will appear normal with greedy MIKBUG taking its 8K of memory, and the 4K RAM board will be in the lower half of memory at its normally addressed position.

Pull the select line to ground and the RAM board will jump 32K higher; half of MIKBUG will disappear. Please note that the RAM board must be addressed to \$7000 for it to take the place of the upper 4K of memory.

Step 4: Decide what type of

circuit to use to control the select line. See Fig. 4. I used circuit A because I didn't need any fancy control. Circuit B or C can be used with a memory-decoded strobe signal (pin 1 of unused I/O ports) or control characters from a terminal such as a CT-64. Any negative-going pulse 2 or more microseconds long will work. The switch in circuit C can be used to prevent damage from wild programs during the debugging stage.

Now I can turn on the computer, use MIKBUG to load a program into the RAM board at \$7000, flick the switch, and I have full control. One nice thing about this memory modification is that all of the MIKBUG rou-

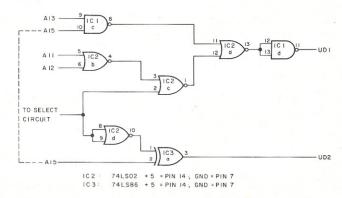
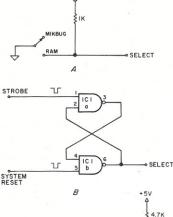


Fig. 3. New address decoding.



tines are still usable and where they belong. There is no need to change an addresses for software currently in use.

A Final Note:

Do not power-on the computer with the RAM board set at \$F000. The processor will rapidly jump to never-never land until brought back by a reset with MIKBUG set correctly.■

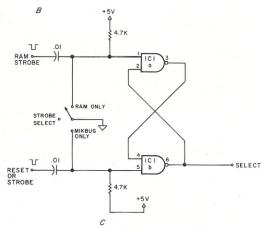
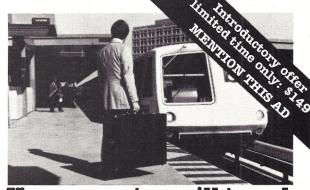


Fig. 4. Select circuits.



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X-Y Plotting With an X-T Plotter

Produce publishable plots with a cheapo chart recorder.

```
2000 REM SHELL-METZNER SORT ON COL KO
2010 N = 99·M = N
2020 M = INT(M/2)
2030 IF M = 0 THEN 2170
2040 K = N - M:J = 1
2050 L=J
2060 L=I+M:IF M%(I+2,K0)>M%(L+2,K0) THEN 2090
2070 J = J + 1:IF J>K THEN 2020
2080 GOTO 2050
2090 REM SWAP ROWS OF M%
2100 FOR P = 0 TO 3
2110 M\%(0,P) = M\%(I + 2,P)
2120 M\%(I + 2,P) = M\%(L + 2,P)
2130 M\%(L + 2,P) = M\%(0,P)
2140 NEXT P
2150 I = I - M:IF I<1 THEN 2070
2160 GOTO 2060
2170 PRINT "SORTED ON COL":K0
2180 RETURN
```

Program for Shell-Metzner sort of rows 2–101 of matrix M% of column K0. Rows 0 and 1 of the matrix contain identification, not data; row 0 is used for temporary storage during the sort. Entire rows are swapped in the loop at 2100–2140. A total of 99 rows of data is ordered on the desired column in about two minutes of computer time.

3500 REM PLOT PT SSR 3505 IF K<0 THEN K = 0 3510 G% = INT(K+SC) + 128 3514 IF G%>383 THEN G% = 127 3515 IF G%>255 THEN G% = G% - 256 3530 OUT 30,G%:GOSUB 2500 3540 IF KT<TI+32 THEN 3530 3550 RETURN

Program to plot a point Y at a specific time T=X. Here the value (Y) to be plotted is K. SC is a scale factor, adjusted elsewhere in the program to ensure that all points fit on the page. Statements 3510-3515 adjust the value to agree with the convention used by the Cromemco D+7A board; this is sent by the OUT 30, G% in 3530. Subroutine 2500 reads the clock and returns a count KT; this is compared to the current value of X, variable TI. The time scale factor 32 is adjusted to suit the paper speed being used. The value of Y is repeatedly sent to the plotter until KT = TI*32, then the RETURN is executed and the next point is processed.

Kenneth Reid 1935 Trevilian Way Louisville, KY 40205

A n X-Y plotter capable of the precision needed to produce publishable plots is expensive—typically over \$1000. A chart recorder of equivalent capability, the Heathkit model IR-18M, costs less than \$200, but can only plot a variable Y against time. A Y-T plotter can be used as an X-Y plotter with a microcomputer. The trick is to convert the independent variable X to time.

How to Do It

I use an Altair 8800 with 24K of memory. The programs are written in Altair (Microsoft) BA-SIC, version 3.3. Analog data is collected using a Cromemco D+7A converter board (see *Microcomputing*, March 1979, p. 40) and saved in Tarbell format on cassette tape. An independent clock that counts seconds is available from a home-brew board.

Conversion of X to T occurs in two stages. The first is software: the data array is read in from tape as a 101 row \times 4 column integer matrix and sorted on the column selected as variable X so that the values of this column are in ascending order. At the same time the other columns are sorted so that the rows are rear-

rånged, but each row remains intact. Using a Shell-Metzner sort, this operation takes about two minutes on my system. (See "Quicksort," *Microcomputing*, April 1979, p. 96.)

The second step is the actual plotting. After plotting a set of calibration marks, the seconds clock resets to zero and begins to count. When the clock count equals or exceeds the first value of column X, the value in the same row for variable Y goes to the plotter pen via the D/A converter. The next X value is then compared, and its Y value sent at the time T exceeds X. This procedure is repeated until the time count T exceeds the largest value of X and the plot is completed (see Fig. 1.)

A useful variation is the histogram format of Fig. 2. For a specified X interval, the corresponding values of Y are averaged, and the mean value is plotted as a bar. The standard deviation is shown as a line above and below the bar.

The procedure is slow, particularly for the histogram format. Since the paper cannot move appreciably during the tracing of a vertical line, and the pen slew time is about one second for full scale, I'm limited to a paper speed of 50 sec/inch or slower. Usually I plot at 100 sec/inch or, for compact plots, 200 sec/inch. One advantage of the Y-T format is that the paper comes

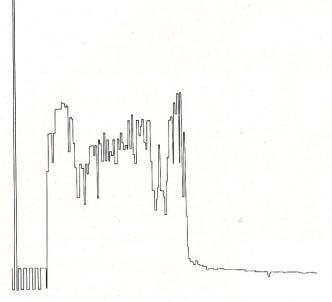


Fig. 1. Sample X-Y plot. Note that the intervals between direction changes of the plot line are variable, due to the X-T conversion. The tall bar at the left defines the available plotting height for Y, while the series of square waves specifies the scaling factor used, and the paper speed.

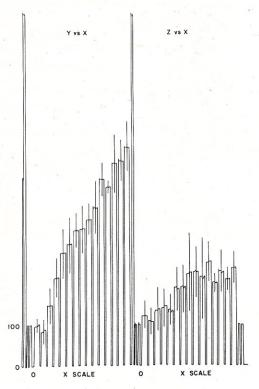


Fig. 2. Pair of plots showing the histogram mode. Two dependent variables, Y and Z, are plotted against X. The value of X ranges from 0 to 700; the bar width is 50. For the first bar, all Y values for rows in which X was between 0 and 50 were averaged, and the result plotted as the height of the bar. The thin line at the midpoint of the bar indicates the standard deviation of the mean for this group of Y values. If no standard deviation is shown, there is only one data point in the interval.

in a roll, letting me run a whole series of plots unattended. This is more convenient than using

an X-Y plotter in which a new sheet of paper must be inserted by hand for each plot.

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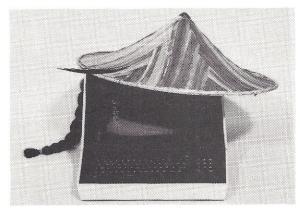
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Patching the SSB Assembler

Making a "super assembler" really super.

John L. Alford 10000 Midlothian Tpk., Box 11 Richmond, VA 23235

ne of the three major disk systems for the SS-50 bus is provided by Smoke Signal Broadcasting. Although its random DOS is a blessing, and the system utilities and software provided with the system put it at the top of the heap, one shortcoming is the assembler utility available for it. Actually a modified Technical Systems Consultants package, it is a bare-bones program that can present problems and irritations if it is used for more than relatively short assemblies.

Line Numbers

My first problem with the Smoke Signal assembler was line numbers: there weren't any. It wasn't a problem at first. A quick routine to increment a double-precision packed BCD number and display it did the trick. I had line numbers . . . all over the place! On every line, as well as the top, bottom, edges and corners of every page, line

numbers appeared. I quickly learned what too much of a good thing meant. That's what happens when you're in a hurry.

The first necessity for numbering is a way to increment the count, but only on source lines, not expansion lines generated by the assembler, such as FCBs, FCCs and SPCs. Look at the program listing. BUMPLI, from lines 122 through 137 in the program listing, accomplishes this by being called from a point in pass two that jumps to parse each line before further assembly. Lines 50-51 are the assembler patch, and BUMPLI exits by jumping to the parse routine called by the original code. The string LINCNT, which BUMPLI increments, is the actual line number that is later optionally printed.

LINCNT must be output only on selected lines. For clarity, I wanted comment lines unnumbered, so I had to find a patch point to allow this. Lines 70-71 patch the number output routine OUTLIN into the listing formatting routine, which Smoke Signal appended to the original assembler to columnize the printout from free-form source code.

Referring to OUTLIN (lines 110-118), the list format routine picks up the first character in the label column. If it is an asterisk, the line is a comment. OUTLIN simply performs the test the assembler used to do the kill column formatting on comments, and exits back to the old code to handle them. After inserting line numbers in the desired lines, OUTLIN jumps back into the old code to handle the rest of the line.

A note here is in order: the patches shown do not take into account the possibility of a system using a 40-column printer such as the SWTP PR-40. The column numbering in the original code has not been patched to take into account the inclusion of six more columns. If you use the PR-40, some experimenting is in order.

Other than that, the assembler couldn't have been more congenial to these patches. Scan the listing and notice that no provision is made to eliminate printing line numbers on skipped lines and expansion lines. The reason is that the assembler doesn't use the LIST routine on those lines. so OUTLIN never is called. One problem down, and one to go.

Optional Printing

For long listings, the option of only printing the part of a listing damaged by a hungry printer is a must! The patches I have writ-

ten provide for that. Fig. 1a shows a typical DOS call for assembly. Commas are delimiters. The source file ASPA10.SRC should be assembled, generating no object file, with a listing to be printed (as opposed to being displayed) without a symbol table listing.

After employing the patches in the listing, the line looks like Fig. 1b. The only change is that now only pages one through four are printed. Fig. 1c is a similar call to the patched assembler, but the option is set to print all pages from page one to the end. Fig. 1d requests that all pages up to and including page four be printed. Fig. 2 shows the format of the new call.

Refer to the listing again. Before the pass-one initialization occurs, the page options are picked up from the DOS line buffer. The SETLIM routine from lines 141-173 accomplishes this. Lines 80-81 are the patch that calls SETLIM, which exits by performing the jump to the pass-one initialization replaced by the patch.

If an error is detected during SETLIM, the limits default to as many of the options as were picked up before the error. This means that if the format in Fig. 2 is not followed, the lower limit may be properly set, but the upper limit will default to the end of the listing.

The second half of the option routine does several things. PROUT (lines 177-218) deter-

ASMB, ASPAlO.SRC,,P,,N ASMB, ASPAlO.SRC,,P,,N,01,04 ASMB, ASPAlO.SRC,,P,,N,01 ASMB, ASPAlO.SRC,,P,,N,04

Fig. 1. DOS Assembly calls.

PRINT OPTION OBJECT FILE SOURCE FILE LIST OPTION SYMBOL OPTION

(IFILE), (OFILE), (P), (N), (N), (XX), (XX)

FIRST PAGE OPTION * LAST PAGE OPTION *

NOTE: IF XX IS NOT TO BE SPECIFIED 'N' MAY BE SUBSTITUTED OR, IF OPTION LINES ARE NOT USED, ',XX,XX' MAY BE DROPPED. IF, HOWEVER, A PAGE OPTION IS TO BE USED A TWO-DIGIT NUMBER MUST BE USED EVEN IF ZERO (00).

Fig. 2. New assembly call format.

mines whether to print a page (lines 206-211), keeps up with the location on a page (lines 188-197), handles the printer/display decision (lines 214-218) and allows form-feed characters generated by the assembler (ASCII \$0C) to cause form-feed on printers that don't support top-of-forms (lines 179-185).

PROUT is called from the jump addresses patched in lines 62-65. With the patches shown in the listing in place, change the addresses in lines 217-218 for display and output routines instead of the old addresses called for by the instruction manual. Lines 60-61 replace the form-feed string incorporated in the original assembler. The new string, together with PROUT, causes an eject to top-of-form and prints a period at the tear point to allow a check on alignment for continuous forms.

Lines 53-57 set up the assembler to handle a 66-line page (8 $1/2 \times 11$ inch forms at six lines to the inch). Notice that the counter location for PROUT. LINECT initially has a value of three because the assembler doesn't know if the listing will run under the PAG option until the OPT pseudo is parsed. Assuming the assembler OPT pseudo is on line two, directly after NAM, two lines print before the assembler starts counting lines (see Listing 1).

One Last Patch

Invariably, in assembly-language programming, you have a stack of listings with changes and updates, and you have no idea which listing is the most current. To overcome this problem, I included the routine MOV- SRC (lines 88-106).

MOVSRC takes the source filename from the read-file control block and stuffs it into the title line in place of SSB MNEMONIC ASSEMBLER. Lines 75-77 patch the banner, and lines 73-74 patch MOVSRC into the end of pass one. Obviously, the program listing was generated from ASPATS.X12. If any pages are replaced later using the print page option, the updated filename will appear on those pages only. This provides numerous benefits.

Conclusion

The patches presented in this article provide one way to make the Smoke Signal assembler as flexible as practical without going to high-priced macro-assemblers. As a convenience for those who wish to incorporate these changes into the SSB assembler but don't like to type, or who wish to make changes without reentering the entire source file, a disk is available from the author for \$17.95, shipping and handling included. Included on the disk is a copy of the source file and assembled object code plus any updates incorporated after publication.

0001: NAM ASSEMBLER OPTIONAL PRINT OVERLAY 0002: OPT NOG , PAG

Listing 1.

	Program listing.
	* GENERAL PROGRAM EQUATES
0038	0029: PRNFLG EQU \$0038 PRINTER OUTPUT FLAG
0326	0030: Plinit EQU \$0326 PASS ONE INITIALIZE
03D9	0031: PASTWO EQU \$03D9 ENTRY POINT FOR PASS TWO
07AB	0032: PDATA EQU \$07AB OUTPUT A STRING
0B75	0033: PARSE EQU \$0B75 LINE PARSING ROUTINE
11B1	0034: TITLES EQU \$11B1 POINTER FOR SOURCE NAME
162F	0035: INCH EQU \$162F KEYBOARD INPUT
1638	0036: COUCH EQU \$1638 TERMINAL OUTPUT
171B	0037: GETIT EQU \$171B GET NEXT CHAR FROM IBF
1798	0038: DASOUC EQU \$1798 PRINTER/TERMINAL OUTPUT
17A3	0039: RFCB EQU \$17A3 INPUT FILE CONTROL BLOCK
19C4 1A81	0040: LIST1 EQU \$19C4 RE-ENTRY POINT TO LIST 0041: COMMT EOU \$1A81 COMMENT HANDLER
729A	0041: COMMT EQU \$1A81 COMMENT HANDLER 0042: ZANCHK EQU \$729A CHECK FOR ALPAHNUMERIC
ElDl	0043: OUTEEE EOU \$EID1 SCREEN OUTPUT
E5B1	0044: PRINTR EQU \$E5B1 PRINTER HANDLER OUTPUT
E59D	0045: PRINIT EQU \$E59D MY PRINTER INITIALIZATION
	* ASSEMBLER PROGRAM PATCHES
	* PASS TWO PATCH TO INCREMENT LINE COUNT
03E8	0050: ORG \$03E8
03E8 BD lA EC	0051: JSR BUMPLI
2200	* PATCH FOR LINES OF PRINT PER PAGE
07C5	0053: ORG \$07C5
07C5 3A	0054: FCB \$3A
1140	* PATCH TO SET LINES FROM TOF TO TITLE
1143	0056: ORG \$1143
1143 05	0057: FCB 5
1101	* PATCH FOR TOP OF FORM STRING
11D1 0C	0059: ORG \$11D1
TIDI UC	0060: FCB \$C,\$2E,\$4
1622	* PATCH FOR FORMAT HANDLER
1632 1632 7E 1B 61	0062: ORG \$1632 0063: JMP PROUT
1635 7E E5 9D	0064: JMP PRINIT
1638 7E 1B 61	0065: JMP PROUT
1030 /1 10 01	* PATCH TO SET NEW END OF PROGRAM
163B	0067: ORG \$163B
163B CE 1B DE	0068: LDX #NEWEND
	* PATCH TO OUTPUT LINE NUMBERS
19BD	0070: ORG \$19BD
19BD 7E 1A D4	0071: JMP OUTLIN
	* PATCH TO INSERT SOURCE FILE NAME INTO BANNER

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						3				
	1711				0073:		ORG		\$1711	
١	1711	BD	1A	A7	0074:		JSR		MOVSRC	
١	11B1				* NEW 0076:	TITLE I			¢1101	
١	1181	46			0076:	- 7	ORG		\$11B1 'FILENAME:	PAGE '
١	1100				0078:		FCB		4	
١	7.	-			4.0000	CH TO P		JP I	-	FROM COMMAND
١	16DB				0080:		ORG		\$16DB	
١	16DB	BD	IB	0D	0081:		JSR		SETLIM	
I					* STAF	RT OF NE	EW RO	ידוו	INES	
	1AA7				0084:		ORG		\$1AA7	
١										
١					* MOVI	E FILE 1	NAME	FRO	OM FCB TO T	ITLE AREA
١	1AA7	CE	11	C4	0088:	MOVSRC	LDX		#TTTLES+19	POINT INTO TITLE STRING
1	laaa				0089:		STX		TEMPX2	AND SAVE IT
I	laad				0090:		LDX		#RFCB+11	POINT TO FCB
1	1ABO					MOVSRl		A	X	GET LAST CHARACTER
1	1AB2 1AB4				0092:		BNE	Δ	*+4 #\$20	BRANCH IF ALPHANUMERIC OTHERWISE PAD IT
1	1AB6	09	- 5		0094:		DEX	**	#420	BUMP POINTER
1	1AB7				0095:		STX		TEMPX1	SAVE IT
1	laba labb			D0	0096: 0097:		LDX	7	TEMPX2	GET NAME POINTER
1	1ABF		00		0098:		DEX	A	Δ.	SAVE IT BUMP POINTER
ı	1AC0	8C		Cl	0099:		CPX		#TITLES+16	EXTENSION POINT?
١	1AC3		01		0100:		BNE		MOVSR2	BRANCH IF NOT
١	1AC5 1AC6		10	DO	0101:	MOVSR2	DEX		mrwpy2	BUMP POINTER ONCE MORE
	1AC9				0102:		LDX		TEMPX2 TEMPX1	SAVE POINTER RESTORE FROM-POINTER
١	lacc				0104:		CPX		#RFCB+2	TRANSFER COMPLETE?
١	lacr				0105:	1	BNE		MOVSRl	LOOP UNTIL DONE
١	lADl	7E	03	D9	0106:		JMP		PASTWO	GO HANDLE PASS TWO
١					* ()[]	מדות דותו	E NID	ADE	R ON SELECT	ED IINES
1					001	FOI DIN	L NO	IDE.	R ON SELECT	ED LINES
1	1AD4					OUTLIN				COMMENT LINE?
١	1AD6 1AD8				0111:		BEQ		OUTLIX	IF SO, EXIT
١	lADB				0112:		STX		TEMPX1 #LINCNT	SAVE LINE POINTER POINT TO LINE STRING
١	1ADE				0114:		JSR		PDATA	OUTPUT THE STRING
١	1AE1			CE	0115:		LDX		TEMPX1	RESTORE X-REG
١	1AE4			0.4	0116:		LDA	A		RESTORE A-REG
١	1AE9				0117:	OUTLIX	JMP		LIST1 COMMT	RE-ENTRY TO LIST LINE RE-ENTRY TO HANDLE COMMENTS
					* BUMI	P LINE	NUMBI	ER I	BEFORE PARS	
	1200	nn	15	an						ING
	laec		18	CE	0122:	BUMPLI	STX		BEFORE PARS	
	laec laer laro	36			0122: 0123:	BUMPLI		A	TEMPX1	ING SAVE REGISTERS
	lAEF lAF0 lAF3	36 CE 09	18		0122: 0123: 0124:	BUMPLI	STX PSH LDX	A		ING
	lAEF lAF0 lAF3 lAF4	36 CE 09 A6	18		0122: 0123: 0124: 0125: 0126:	BUMPLI BUMPL1	STX PSH LDX DEX LDA	A A	TEMPX1	ING SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS
	1AEF 1AF0 1AF3 1AF4 1AF6	36 CE 09 A6 4C	1B 00		0122: 0123: 0124: 0125: 0126: 0127:	BUMPLI BUMPL1	STX PSH LDX DEX LDA INC	A A A	TEMPX1 #LINCNT+4 X	ING SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF7	36 CE 09 A6 4C A7 81	1B 00 00 3A	DB	0122: 0123: 0124: 0125: 0126: 0127: 0128:	BUMPLI BUMPL1	STX PSH LDX DEX LDA INC STA	A A A	TEMPX1 #LINCNT+4 X	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT
	lAEF lAF0 lAF3 lAF4 lAF6 lAF7	36 CE 09 A6 4C A7 81	1B 00 00 3A	DB	0122: 0123: 0124: 0125: 0126: 0127: 0128:	BUMPLI BUMPL1	STX PSH LDX DEX LDA INC STA CMP BNE	A A A A	TEMPX1 #LINCNT+4 X X #\$3A BUMPLX	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT. EXIT
	lAEF lAF0 lAF3 lAF4 lAF6 lAF7	36 CE 09 A6 4C A7 81	1B 00 00 3A	DB	0122: 0123: 0124: 0125: 0126: 0127: 0128:	BUMPLI BUMPL1	STX PSH LDX DEX LDA INC STA CMP BNE LDA	A A A A	TEMPX1 #LINCNT+4 X X #\$3A BUMPLX #\$30	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW?
	lAEF lAF0 lAF3 lAF4 lAF6 lAF7 lAF9 lAFB lAFD	36 CE 09 A6 4C A7 81 26 86 A7	1B 00 00 3A 09 30	DB	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0129: 0130: 0131: 0132:	BUMPLI BUMPL1	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA	A A A A A	TEMPX1 #LINCNT+4 X X #\$3A BUMPLX #\$30 X	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF	36 CE 09 A6 4C A7 81 26 86 A7	1B 00 00 3A 09 30 00 1B	DB	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0129: 0130: 0131: 0133:	BUMPLI BUMPL1	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA	A A A A A	TEMPX1 #LINCNT+4 X X #\$3A BUMPLX #\$30 X *LINCNT	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF7 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32	1B 00 00 3A 09 30 00 1B ED	DB	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0130: 0131: 0132: 0133: 0134: 0135:	BUMPL1 BUMPL1	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA	A A A A A	TEMPX1 #LINCNT+4 X X #\$3A BUMPLX #\$30 X *LINCNT	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF7 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE	1B 00 00 3A 09 30 00 1B ED	DB D7 CE	0122: 0123: 0124: 0125: 0126: 0127: 0129: 0130: 0131: 0132: 0133: 0134: 0136:	BUMPL1 BUMPLX	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX	A A A A A A	TEMPX1 # LINCNT+4 X X #\$3A BUMPLX #\$30 X # LINCNT BUMPL1 TEMPX1	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF7 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE	1B 00 00 3A 09 30 00 1B ED	DB D7 CE	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0130: 0131: 0132: 0133: 0134: 0135:	BUMPL1 BUMPLX	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX	A A A A A A	TEMPX1 # LINCNT+4 X X #\$3A BUMPLX #\$30 X # LINCNT BUMPL1 TEMPX1	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF7 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE	1B 00 00 3A 09 30 00 1B ED	DB D7 CE	0122: 0123: 0124: 0125: 0126: 0127: 0129: 0130: 0131: 0132: 0133: 0134: 0135: 0137:	BUMPL1 BUMPLX	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX JMP	A A A A A	TEMPX1 #LINCNT+4 X X #\$3A BUMPLX #\$30 X #LINCNT BUMPL1 TEMPX1 PARSE	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06 1B07	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE 7E	1B 00 00 3A 09 30 00 1B ED	DB D7 CE 75	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0130: 0131: 0132: 0133: 0134: 0135: 0136: 0137:	BUMPL1 BUMPLX PRINTE	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX JMP	A A A A A A	TEMPX1 # LINCNT+4 X X #\$3A BUMPLX #\$30 X #LINCNT BUMPL1 TEMPX1 PARSE	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06 1B07	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE 7E	1B 00 00 3A 09 30 00 1B ED	DB D7 CE 75	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0130: 0131: 0132: 0133: 0134: 0135: 0136: 0137:	BUMPL1 BUMPLX PRINTE	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX JMP	A A A A A A	TEMPX1 # LINCNT+4 X X #\$3A BUMPLX #\$30 X #LINCNT BUMPL1 TEMPX1 PARSE	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06 1B07	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE 7E	1B 00 00 3A 09 30 00 1B ED	DB D7 CE 75	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0130: 0131: 0132: 0133: 0134: 0135: 0136: 0137:	BUMPL1 BUMPLX PRINTE	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX JMP	A A A A A A	TEMPX1 # LINCNT+4 X X #\$3A BUMPLX #\$30 X #LINCNT BUMPL1 TEMPX1 PARSE	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06 1B07	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE 7E	1B 00 00 3A 09 30 00 1B ED	DB D7 CE 75	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0130: 0131: 0132: 0133: 0134: 0135: 0136: 0137:	BUMPL1 BUMPLX PRINTE	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX JMP	A A A A A A	TEMPX1 # LINCNT+4 X X #\$3A BUMPLX #\$30 X #LINCNT BUMPL1 TEMPX1 PARSE	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06 1B07	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE 7E	1B 00 00 3A 09 30 00 1B ED	DB D7 CE 75	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0130: 0131: 0132: 0133: 0134: 0135: 0136: 0137:	BUMPL1 BUMPLX PRINTE	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX JMP	A A A A A A	TEMPX1 # LINCNT+4 X X #\$3A BUMPLX #\$30 X #LINCNT BUMPL1 TEMPX1 PARSE	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06 1B07	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE 7E	1B 00 00 3A 09 30 00 1B ED	DB D7 CE 75	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0130: 0131: 0132: 0133: 0134: 0135: 0136: 0137:	BUMPL1 BUMPLX PRINTE	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX JMP	A A A A A A	TEMPX1 # LINCNT+4 X X #\$3A BUMPLX #\$30 X #LINCNT BUMPL1 TEMPX1 PARSE	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B06 1B07	36 CE 09 A6 4C A7 81 26 86 A7 8C 26 32 FE 7E	1B 00 00 3A 09 30 00 1B ED	DB D7 CE 75	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0130: 0131: 0132: 0133: 0134: 0135: 0136: 0137:	BUMPL1 BUMPLX PRINTE	STX PSH LDX DEX LDA INC STA CMP BNE LDA STA CPX BNE PUL LDX JMP	A A A A A A	TEMPX1 # LINCNT+4 X X #\$3A BUMPLX #\$30 X #LINCNT BUMPL1 TEMPX1 PARSE	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B07 1B0A 1B0D 1B0D 1B0D 1B11 1B14 1B16 1B19 1B19	36 CE 09 A6 4C A71 826 A7 8C 26 32 FE 7E 81 27 BD 27 BD 4 24 BD 27	1B 00 00 3A 00 30 00 1B ED 1B 0B	DB D7 CE 75 1B 9A 1B	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0129: 0130: 0132: 0133: 0134: 0135: 0136: 0137: * SET 0141: 0142: 0143: 0144: 0145: 0146: 0147:	BUMPLI BUMPLX PRINTE: SETLIM	STX PSH LDX DEX LDA LDX CMP BNE LDA CPX BNE LDA LDX	A A A A A A	TEMPX1 \$LINCNT+4 X X \$\$3A BUMPLX \$\$30 X \$LINCNT BUMPL1 TEMPX1 PARSE 6 \$\$D SETLIX GETLIX ZANCHK SETLIX ZANCHK SETLIO GETLIT SETLIX	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE NO LIMIT OPTION? EXIT IF NONE GET NEXT CHAR EXIT IF CR CHECK IF ALPHANUMERIC BRANCH IF OPTION NUMBER GET FIRST OPTION NUMBER EXIT IF NONE
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF9 1AFB 1AFD 1AFF 1B01 1B04 1B07 1B0A 1B0D 1B0D 1B0D 1B11 1B14 1B16 1B19 1B19	36 CE 09 A6 4C A71 826 A7 8C 26 32 FE 7E 81 27 BD 27 BD 4 24 BD 27	1B 00 00 3A 00 30 00 1B ED 1B 0B	DB D7 CE 75 1B 9A 1B	0122: 0123: 0124: 0125: 0126: 0127: 0128: 0129: 0130: 0132: 0133: 0134: 0135: 0136: 0137: * SET 0141: 0142: 0143: 0144: 0145: 0146: 0147:	BUMPLI BUMPLX PRINTE: SETLIM	STX PSH LDX DEX LDA LDX CMP BNE LDA CPX BNE LDA LDX	A A A A A A	TEMPX1 \$LINCNT+4 X X \$\$3A BUMPLX \$\$30 X \$LINCNT BUMPL1 TEMPX1 PARSE 6 \$\$D SETLIX GETLIX ZANCHK SETLIX ZANCHK SETLIO GETLIT SETLIX	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE NO LIMIT OPTION? EXIT IF NONE GET NEXT CHAR EXIT IF CR CHECK IF ALPHANUMERIC BRANCH IF OPTION NUMBER GET FIRST OPTION NUMBER EXIT IF NONE
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	1AEF 1AF0 1AF3 1AF4 1AF6 1AF7 1AFB 1AFB 1AFD 1B0A 1B0A 1B0A 1B0A 1B1 1B14 1B14 1B16 1B19 1B18 1B18 1B19 1B18 1B19 1B18 1B19 1B18 1B19 1B18 1B19 1B18 1B19 1B19	36 CE 0 9 6 AC 7 8 2 6 8 6 A 7 8 2 6 3 2 F F 7 E 8 2 7 B 2 7 B 2 5 7 B B 2 5 B B 7 B B 2 5 B B 7 B B 2 5 B B 7 B B 8 5 B 7 B 8	1B 00 00 30 00 1B 1B 0B 0D 17 48 72 51 17 18 2A 1B 1B 1B 1B	DB D7 CE 75 1B 9A 1B B5 D2 1B B5 C2 D4 1B	0122: 0123: 0124: 0125: 0126: 0127: 0130: 0131: 0131: 0133: 0134: 0137: * SET 0141: 0142: 0143: 0144: 0145: 0146: 0147: 0152: 0150: 0151: 0151: 0155: 0156: 0157:	BUMPLI BUMPLX PRINTE: SETLIM SETLIO	STX PSH LDX LDA LDA STA CPX BNE CPX BNE CPX LDA LDX JMP R LIN CMP BEQ JSR STA BCS STA BCS STA STA STA STA STA STA STA STA STA ST	A A A A A A A A	TEMPX1 \$LINCNT+4 X X \$\$3A BUMPLX \$\$30 X \$LINCNT BUMPL1 TEMPX1 PARSE S \$\$D SETLIX GETIT SETLIX ZANCHK SETLIX ETLIX ETLIX INUMBER SETLIX TEMPA GETIT NUMBER SETLIX ADDNUM LOWLIM GETIT	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE NO LIMIT OPTION? EXIT IF NONE GET NEXT CHAR EXIT IF CR CHECK IF ALPHANUMERIC BRANCH IF OPTION NUMBER GET FIRST OPTION NUMBER EXIT IF NONE NO LOWER LIMIT? BRANCH IF NOT CHECK FOR GOOD NUMBER EXIT IF NOT SAVE IT CHECK FOR GOOD EXIT IF NOT ADD HALVES OF BYTE AND SET LOWER LIMIT GET NEXT
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF7 1AFB 1AFB 1AFD 1B0A 1B0A 1B0A 1B0A 1B1 1B14 1B14 1B16 1B19 1B18 1B18 1B19 1B18 1B19 1B18 1B19 1B18 1B19 1B18 1B19 1B18 1B19 1B19	36 CE 0 9 6 AC 7 8 2 6 8 6 A 7 8 2 6 3 2 F F 7 E 8 2 7 B 2 7 B 2 5 7 B B 2 5 B B 7 B B 2 5 B B 7 B B 2 5 B B 7 B B 8 5 B 7 B 8	1B 00 00 30 00 1B 1B 0B 0D 17 48 72 51 17 18 2A 1B 1B 1B 1B	DB D7 CE 75 1B 9A 1B B5 D2 1B B5 C2 D4 1B	0122: 0123: 0124: 0125: 0126: 0127: 0130: 0131: 0131: 0133: 0134: 0137: * SET 0141: 0142: 0143: 0144: 0145: 0146: 0147: 0152: 0150: 0151: 0151: 0155: 0156: 0157:	BUMPLI BUMPLX PRINTE: SETLIM SETLIO	STX PSH LDX LDA LDA STA CPX BNE CPX BNE CPX LDA LDX JMP R LIN CMP BEQ JSR STA BCS STA BCS STA STA STA STA STA STA STA STA STA ST	A A A A A A A A	TEMPX1 \$LINCNT+4 X X \$\$3A BUMPLX \$\$30 X \$LINCNT BUMPL1 TEMPX1 PARSE S \$\$D SETLIX GETIT SETLIX ZANCHK SETLIX ETLIX ETLIX INUMBER SETLIX TEMPA GETIT NUMBER SETLIX ADDNUM LOWLIM GETIT	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE NO LIMIT OPTION? EXIT IF NONE GET NEXT CHAR EXIT IF CR CHECK IF ALPHANUMERIC BRANCH IF OPTION NUMBER GET FIRST OPTION NUMBER EXIT IF NONE NO LOWER LIMIT? BRANCH IF NOT CHECK FOR GOOD NUMBER EXIT IF NOT SAVE IT CHECK FOR GOOD EXIT IF NOT ADD HALVES OF BYTE AND SET LOWER LIMIT GET NEXT
	1AEF 1AF0 1AF3 1AF4 1AF6 1AF7 1AFB 1AFB 1AFD 1B0A 1B0A 1B0A 1B0A 1B1 1B14 1B14 1B16 1B19 1B18 1B18 1B19 1B18 1B19 1B18 1B19 1B18 1B19 1B18 1B19 1B18 1B19 1B19	36 CE 0 9 6 AC 7 8 2 6 8 6 A 7 8 2 6 3 2 F F 7 E 8 2 7 B 2 7 B 2 5 7 B B 2 5 B B 7 B B 2 5 B B 7 B B 2 5 B B 7 B B 8 5 B 7 B 8	1B 00 00 30 00 1B 1B 0B 0D 17 48 72 51 17 18 2A 1B 1B 1B 1B	DB D7 CE 75 1B 9A 1B B5 D2 1B B5 C2 D4 1B	0122: 0123: 0124: 0125: 0126: 0127: 0130: 0131: 0131: 0133: 0134: 0137: * SET 0141: 0142: 0143: 0144: 0145: 0146: 0147: 0152: 0150: 0151: 0151: 0155: 0156: 0157:	BUMPLI BUMPLX PRINTE: SETLIM SETLIO	STX PSH LDX LDA LDA STA CPX BNE CPX BNE CPX LDA LDX JMP R LIN CMP BEQ JSR STA BCS STA BCS STA STA STA STA STA STA STA STA STA ST	A A A A A A A A	TEMPX1 \$LINCNT+4 X X \$\$3A BUMPLX \$\$30 X \$LINCNT BUMPL1 TEMPX1 PARSE S \$\$D SETLIX GETIT SETLIX ZANCHK SETLIX ETLIX ETLIX INUMBER SETLIX TEMPA GETIT NUMBER SETLIX ADDNUM LOWLIM GETIT	SAVE REGISTERS POINT TO STRING AGAIN BUMP POINTER GET UNITS BUMP IT SAVE IT OVERFLOW? IF NOT, EXIT OTHERWISE GET ZERO DONE? IF NOT, LOOP RESTORE REGISTERS GO PARSE LINE NO LIMIT OPTION? EXIT IF NONE GET NEXT CHAR EXIT IF CR CHECK IF ALPHANUMERIC BRANCH IF OPTION NUMBER EXIT IF NONE NO LOWER LIMIT? BRANCH IF NOT CHECK FOR GOOD NUMBER EXIT IF NOT SAVE IT GET NEXT CHECK FOR GOOD EXIT IF NOT ADD HALVES OF BYTE AND SET LOWER LIMIT GET NEXT EXIT ON NO UPPER CHECK FOR NO COMMAND EXIT IF SO

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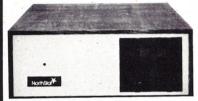


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B861 81 0D	IDJE	12	03	20						
B86 81 00 0191; D87 0196 197 0197	1061	0.1	ΔD							
BB69 BD 0 80 1891; PROUTH BSR OUTCRO										
B66 B6 B D6 D182; D10 A LINECT LINECT LINE COUNTER LINE COUNTER LINECT LINE COUNTER LINECT LINE COUNTER LINE					0179:					
B86	1B69	8D	08		0180:	PROUT1	BSR		OUTCRO	
1875 80	1B6B	B6	1B	DE	0102.		LDA	A	LINECT	
1875 80					0183:					
1877 86 18					0.192:		RTS			
LB78 84 44 0190; CMP A	1B75	8D	22		0187:		BSR		OUTCH	
1876 81 44 0190; CMP 4 \$4.44 END OF FORM? 1877 86 08 0191; BNE OUTCRI 1878 86 01 0193; ADD A 1 1884 89 0194; DAA DAA 1884 19 0194; DAA DAA 1885 87 18 D5 0195; STA A PAGCNT 1880 86 01 0196; LDA A 1 1880 87 18 D6 0197; OUTCRI STA A LINECT 1880 86 01 0196; LDA A 4 1880 87 18 D6 0197; OUTCRI STA A LINECT 1880 87 0198; PSH B 1880 60 0199; LDA A \$5 1890 80 00 0200; LDA A \$5 1890 80 05 0201; BSR OUTCH 1892 80 05 0201; BSR OUTCH 1894 4F 0202; CLR A 1895 5A 0203; DEC B 1896 26 FA 0204; BNE *-4 AND SAVE COUNT 1899 36 0206; OUTCH PSH A 1890 81 18 D4 0208; CMP A LOWLIM 1800 25 05 0209; BCS OUTCH 1801 25 05 0209; BCS OUTCH 1802 25 0209; BCS OUTCH 1803 23 02 0211; BLS OUTCH 1804 23 02 0212; OUTCH PUL A 1804 27 0212; OUTCH PUL A 1805 27 0214; OUTCH PUL A 1806 03 0216; SNE OUTCH 1807 72 0214; OUTCH PUL A 1808 27 0214; OUTCH PUL A 1809 27 0214; OUTCH PUL A 1809 28 0214; OUTCH PUL A 1800 20 0214; OUTCH PUL A 1800 03 0216; SNE OUTCH 1800 03 0221; OUTCH PUL A 1800 03 0221; OUTCH OUTCH 1800 00 0222; NUMBER OUTCH 1800 00 00 00 00 00 1800 00 00 00						OUTCR				
B85 87 18 D5 0195; STA A PAGCNT B88 86 01 0196; LDA A \$1	1B7B	81	44		0190:		CMP	A	#\$44	END OF FORM?
B85 87 18 D5 0195; STA A PAGCNT B88 86 01 0196; LDA A \$1	1B7D 1B7F	26 B6	0B	D5	0191:		BNE	Δ	OUTCR1 PAGCNT	BRANCH IF NOT OTHERWISE GET PAGE COUNT
188	1B82	8B	01		0193:		ADD	A		BUMP IT
188	1B84 1B85	19 B7	lB	D5	0194:				PAGCNT	
188D 37	1B88	86	01		0196:	011777	LDA	A	#1	AND SET TO TOP OF FORM
188E C6 04 0199; LDA B #4 GET PAD NULL COUNT 1892 8D 05 0201; BSR OUTCH 1894 4F 0202; CLR A 1895 5A 0203; DEC B 1896 26 FA 0204; BNE *-4 AND SET FOR PADDING NUI 1898 33 0205; PUL B RESTORE B=REG SAVE CHARACTER 1898 8J 3 0205; PUL B RESTORE B=REG SAVE CHARACTER GET CARRY 1890 BH 18 D4 0208; CMP A LOWLIM CHECK RANGE 18A2 25 05 0209; BCS OUTCH 18A2 BH 18 D3 0210; CMP A HILIM CHECK RANGE 18A3 23 02 0211; BLS OUTCH 18A3 23 02 0212; OUTCH PUL A RESTORE CHARACTER RETURN IF NOT IONE 18A3 39 0213; RTS RESTORE CHARACTER RETURN IF NOT IONE GET CHARACTER RETURN IF NOT IONE GET CHECK FANGE 18A4 7D 00 38 0215; TST PRNFLG GET CHARACTER RETURN IF NOT IN RANGE 18A4 7D 00 38 0216; BNE OUTCH PUL A RESTORE CHARACTER RETURN IF NOT IN RANGE 18A5 7E E5 B1 0218; OUTCH PUL A P										
1896 26 FA 0.204; BNE *-4 AND LOOP UNTIL DONE 1898 33 0.205; DUL B RESTORE B_REG 1899 36 0.206; OUTCH PSH A 1890 B1 B D4 0.208; CMP A LOWLIM 1800 25 0.209; BCS OUTCHO BRANCH IF NOT TIME 1814 23 0.2 0.211; BLS OUTCH1 1815 23 0.2 0.211; BLS OUTCH1 1816 23 0.2 0.212; OUTCH0 PUL A 1816 39 0.213; RTS RETURN IF NOT DONE 1816 23 0.2 0.214; OUTCH1 PUL A 1816 39 0.216; BNE OUTCH2 1816 30 0.216; BNE OUTCH2 1817 72 E5 B1 0.218; OUTCH2 JMP OUTEE OUTPUT TO SCREEN 1818 23 0.222; NUMBER CMP A \$5.30 1816 39 0.224; CMP A \$5.30 1817 25 0.5 0.223; BCS NUMBER 1818 30 0.222; NUMBER CMP A \$5.30 1819 81 39 0.224; CMP A \$5.30 1810 30 0.225; BLS NUMBE1 1810 30 0.226; SEC SEC 1810 30 0.227; NUMBEX RTS 1810 30 0.227; NUMBEX RTS 1810 30 0.228; NUMBE1 CLC 1810 30 0.227; NUMBER CTC 1810 30 0.228; NUMBE1 CLC 1810 30 0.227; NUMBER CTC 1810 30 0.228; NUMBE1 CLC 1810 30 0.228; NUMBE1 CLC 1810 30 0.229; ASL A 1810 30 0.241; RTS AND SHIFT INTO HI NIBB 1810 30 0.241; RTS AND RETURN * TEMPORARY STORAGE 1810 30 0.241; TRTS AND RETURN * TEMPORARY STORAGE 1810 30 0.241; TRTS AND OUTED OU	1B8E	C6	04		0199:		LDA	В	# 4	GET PAD NULL COUNT
1896 26 FA 0.204; BNE *-4 AND LOOP UNTIL DONE 1898 33 0.205; DUL B RESTORE B_REG 1899 36 0.206; OUTCH PSH A 1890 B1 B D4 0.208; CMP A LOWLIM 1800 25 0.209; BCS OUTCHO BRANCH IF NOT TIME 1814 23 0.2 0.211; BLS OUTCH1 1815 23 0.2 0.211; BLS OUTCH1 1816 23 0.2 0.212; OUTCH0 PUL A 1816 39 0.213; RTS RETURN IF NOT DONE 1816 23 0.2 0.214; OUTCH1 PUL A 1816 39 0.216; BNE OUTCH2 1816 30 0.216; BNE OUTCH2 1817 72 E5 B1 0.218; OUTCH2 JMP OUTEE OUTPUT TO SCREEN 1818 23 0.222; NUMBER CMP A \$5.30 1816 39 0.224; CMP A \$5.30 1817 25 0.5 0.223; BCS NUMBER 1818 30 0.222; NUMBER CMP A \$5.30 1819 81 39 0.224; CMP A \$5.30 1810 30 0.225; BLS NUMBE1 1810 30 0.226; SEC SEC 1810 30 0.227; NUMBEX RTS 1810 30 0.227; NUMBEX RTS 1810 30 0.228; NUMBE1 CLC 1810 30 0.227; NUMBER CTC 1810 30 0.228; NUMBE1 CLC 1810 30 0.227; NUMBER CTC 1810 30 0.228; NUMBE1 CLC 1810 30 0.228; NUMBE1 CLC 1810 30 0.229; ASL A 1810 30 0.241; RTS AND SHIFT INTO HI NIBB 1810 30 0.241; RTS AND RETURN * TEMPORARY STORAGE 1810 30 0.241; TRTS AND RETURN * TEMPORARY STORAGE 1810 30 0.241; TRTS AND OUTED OU	1B90	8D	05		0200:		BSR		OUTCH	
1893 36	1B94	4F			0202:		CLR	A		AND SET FOR PADDING NULLS
1893 36	1B96	26	FA		0204:		BNE		*-4	AND LOOP UNTIL DONE
LB9A B6	1898	33			0205:		PUL	В		RESTORE D-REG
BBAD 25 05 0209: BCS OUTCHO BRANCH IF NOT TIME	1B9A	B6	1B	D5	0207:		LDA	A	PAGCNT	GET CURRENT PAGE
18A2 B1 B D3	1B9D 1BA0	B1 25	1B 05	D4	0208:					
BBA7 32	1BA2	Bl	18		0210:		CMP	A	HILIM	CHECK RANGE
BAB	1027	22			0211:	OUTCHO	BLS	А	OUTCHI	
18AA 7D 00 38 0215: TST PRNFLG CHECK IF PRINTER 18AD 26 03 0216: BNE OUTCH2 BRANCH IF SO 18AF 7E El D1 0217: JMP OUTEEE OUTPUT TO SCREEN 18B2 7E E5 B1 0218: OUTCH2 JMP PRINTR GO OUTPUT TO PRINTER ** CHECK FOR ASCII NUMERIC** ** CHECK FOR NUMERIC** ** EXIT IF NOT NUMERIC** ** EXIT IF NOT NUMERIC** ** EXIT IF NOT NUMERIC** ** SET CARRY AND EXIT CHECK** ** SET CARRY AND EXIT** ** AND EXIT** ** AND EXIT** ** AND EXIT** ** ADD ACCUMULATOR TO TEMPA** ** AND EXIT** ** ADD ACCUMULATOR TO TEMPA** ** AND EXIT** ** ADD ACCUMULATOR TO TEMPA** ** AND EXIT** ** AND EXIT** ** AND EXIT** ** AND SHIFT INTO HI NIBB** ** TEMPORARY STORAGE** ** TEMPORATY STO	1878	30			0213:		RTS			RETURN IF NOT IN RANGE
BAD 26 03	lbaa	7D	00	38	0215:			A	PRNFLG	
* CHECK FOR ASCII NUMERIC * CHECK FOR NUMERIC * CHECK FOR NUMERIC * CHECK FOR NUMERIC * BCS NUMBEX EXIT IF NOT * BBB 81 39 0224: CMP A \$\$39 NEXT CHECK * BBB 23 02 0225: BLS NUMBE1 BRANCH IF OK * BBB 0D 0226: SEC SET CARRY * LBBE 39 0227: NUMBEX RTS AND EXIT * LBBF OC 0228: NUMBE1 CLC CLEAR CARRY * ADD ACCUMULATOR TO TEMPA * ADD SAVE IT * BCC 84 0F 0233: ADDNUM AND A \$\$F MASK TO BCD * SAVE IT * BCC 948 0236: ASL A * BCC 48 0236: ASL A * BCC 48 0237: ASL A * BCC 48 0239: ASL A * BCC 1B 0240: ABA ADD IN LOW * ADD IN LOW * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORARY STORAGE * TEMPORATY STORAGE * TEMPORARY STORAGE * TEMPORATY STOR	1BAD	26	03	D1	0216:					
* CHECK FOR ASCII NUMERIC LBB5 81 30	1BB2	7E	E5	Bl	0217:	OUTCH2	JMP		PRINTR	GO OUTPUT TO SCREEN
LBB5 81 30					* CHE	CK FOR A	ASCI	I N	UMERIC	
BBF 25 05	1885	81	30		0222.	NUMBED	CMD	Λ	#630	CHECK FOR NUMERIC
BBB 23 02	1BB7	25	05		0223:					
BBD 0D										
BCO 20 FC 0229: BRA NUMBEX AND EXIT	1BBD	0D			0226:		SEC		NONDEL	SET CARRY
BCO 20 FC 0229: BRA NUMBEX AND EXIT										AND EXIT
BBC2 84 0F									NUMBEX	
BC4 16					* ADD	ACCUMUI	LATO	RT	О ТЕМРА	
BC4 16	1BC2	84	OF		0233:	ADDNUM	AND	Α	#\$F	MASK TO BCD
BC8 48	1BC4	16			0234:		TAB			SAVE IT
BC9 48	1BC8	48		D2	0236:					GET OTHER HALF AND SHIFT INTO HI NIBBLE
1BCB 48 0239: ASL A 1BCC 1B 0240: ABA ADD IN LOW 1BCD 39 0241: RTS AND RETURN * TEMPORARY STORAGE 1BCE 00 00 0245: TEMPX1 FDB 0 1BD0 00 00 0246: TEMPX2 FDB 0 1BD2 00 0247: TEMPA FCB 0 1BD3 99 0248: HILIM FCB \$99 1BD4 00 0249: LOWLIM FCB 0 1BD5 00 0250: PAGCNT FCB 0 1BD6 03 0251: LINECT FCB 3 ADJUSTED FOR TITLE					0237:		ASL	A		The state of the s
BCD 39	1BCB	48								
* TEMPORARY STORAGE 1BCE 00 00 0245: TEMPX1 FDB 0 1BD0 00 00 0246: TEMPX2 FDB 0 1BD2 00 0247: TEMPA FCB 0 1BD3 99 0248: HILIM FCB \$99 1BD4 00 0249: LOWLIM FCB 0 1BD5 00 0250: PAGCNT FCB 0 1BD6 03 0251: LINECT FCB 3 ADJUSTED FOR TITLE										
1BCE 00 00 0245: TEMPX1 FDB 0 1BD0 00 00 0246: TEMPX2 FDB 0 1BD2 00 0247: TEMPA FCB 0 1BD3 99 0248: HILIM FCB \$99 1BD4 00 0249: LOWLIM FCB 0 1BD5 00 0250: PAGCNT FCB 0 1BD6 03 0251: LINECT FCB 3 ADJUSTED FOR TITLE							1			AND RETURN
1BD0 00 00 0246: TEMPX2 FDB 0 1BD2 00 0247: TEMPA FCB 0 1BD3 99 0248: HILIM FCB \$99 1BD4 00 0249: LOWLIM FCB 0 1BD5 00 0250: PAGCNT FCB 0 1BD6 03 0251: LINECT FCB 3 ADJUSTED FOR TITLE	lece	0.0	0.0							
1BD2 00 0247: TEMPA FCB 0 1BD3 99 0248: HILIM FCB \$99 1BD4 00 0249: LOWLIM FCB 0 1BD5 00 0250: PAGCNT FCB 0 1BD6 03 0251: LINECT FCB 3 ADJUSTED FOR TITLE	1BD0	00	00							
1BD4 00 0249: LOWLIM FCB 0 1BD5 00 0250: PAGCNT FCB 0 1BD6 03 0251: LINECT FCB 3 ADJUSTED FOR TITLE					0247:	TEMPA	FCB		0	
	1BD4	00			0249:	LOWLIM	FCB		0	
	1BD5 1BD6	00			0250:	PAGCNT	FCB		0	ADJUSTED FOR TITE
"LESSAGE STUKAGE									,	ADDUCTED FOR TITLE
IDD7 20 0055 TOWN	1007	2.0								
1BD7 30 0255: LINCNT FCC '0000: ' 1BDD 04 0256: FCB 4										
1BDE 0257: NEWEND EQU *	1BDE				0257:	NEWEND	EQU			
0258: END					0258:		END	,		

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*PROGRAMS ARE INTEGRATED-

01 = ENTER NAMES/ADDRESS, ETC.

02 = *ENTER/PRINT INVOICES

03 = *ENTER PURCHASES

04 = *ENTER A/C RECEIVABLES

05 = *ENTER A/C PAYABLES

06 = ENTER/UPDATE INVENTORY

07 = ENTER/UPDATE ORDERS

08 = ENTER/UPDATE BANKS

09 = EXAMINE/MONITOR SALES LEDGER

10 = EXAMINE/MONITOR PURCHASE LEDGER

11 = EXAMINE/PRINT INCOMPLETE RECORDS

12 = EXAMINE PRODUCT SALES

SELECT FUNCTION BY NUMBER

13 = PRINT CUSTOMER STATEMENT

14 = PRINT SUPPLIER STATEMENTS

15 = PRINT AGENT STATEMENTS

16 = PRINT TAX STATEMENTS

17 = PRINT WEEK/MONTH SALES 18 = PRINT WEEK/MONTH PURCHASES

19 = PRINT YEAR AUDIT

20 = PRINT PROFIT/LOSS ACCOUNT

21 = UPDATE END MONTH FILES

22 = PRINT CASH FLOW FORECAST

23 = ENTER/UPDATE PAYROLL (NOT YET AVAILABLE)

24 = RETURN TO BASIC

WHICH ONE? (ENTER 1-24)

Each program goes to sub menu, e.g.:
(9) allows A. LIST ALL SALES: B. MONITOR SALES BY STOCK CODES:

C. RETRIEVE INVOICE DETAILS; D. AMEND LEDGER FILES;

E. LIST TOTAL ALL SALES

Think of the possibilities and add to those here if you wish.

Price for current package Version 1 is \$550, or Version 2 (including aged debtors analysis, etc.) is \$750, or full listing. \$300. All programs in BASIC for SWTP 6800/Pet 16/32K Systems/Z80 Stroke CPM Systems/Package includes 31 programs

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● e record create/delete/amend/print 4 ways

• • • record sort by any field both alpha or numeric

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• • • four arithmetic functions to use as calculator on last four fields

● ● ● auto check to prevent double entry with file management system dynamically allocating information for minimum disk space consumption.

 Auto invoice numbering (with override option), plus auto printout integrated with stock and address files for payment term discount, agent allocation, price index retrieval and auto stock update; nominal codes retrieved from address files may be optionally overridden.

• Powerful alternative double entry system providing a bureaux type facility for tracking monthly trading figures and tax accruals.

 Currently using 16 sale and 66 purchase commodity codes which are automatically written into ledgers from address files (includes override option).

 Automatic triple posting of sales/purchases to invoice & general & open item ledgers with complete audit trail to include account verification on payments in/out, so that discrepancies are re-allocated to outstanding accounts. This facilitates part

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Disassembler For the 1802

More efficient and readable than coding sheets is this 1802 disassembler.

John Beringer 2728 West Sahara, Apt. 2 Las Vegas, NV 89102

by the time I've gone from the beginning to the end of an 1802 program, written for my Elf II. I have accumulated many sheets of code (not necessarily arranged in any particular order). If I were to reexamine these numerous sheets (which I rarely do), I would find on them scratchings, scribblings, calculations and patches written in the narrow margins complete

with arrows pointing to the address of insertion in the onceneat column of op codes. Perhaps this is why I do not often reread any finished work.

Oh, but wait! There was a certain hexadecimal-to-base-ten conversion routine that worked especially well in this or that program. Now, where was it? After searching twice through 23 pages of unreadable code, I finally find the routine. Now to the user's manual to see what the op codes mean. Wonder why I did it that way? Oh, no! Long Branch to the end of the program. Back to the stack to look for page 23 to see what happens there, and so on.

What I need is a neat, attractive way of displaying what I have written. Hence, the Disassembler. And since software for the 1802 has been as scarce as diamonds in dirt, I'll have to write it myself. First, I need a character generator. Add a few tables of op code mnemonics, stir well with a dash of patience, and the job is done.

Program Breakdown

Addresses 0000 through 0014

contain an initialization routine that sets the interrupt pointer, R1, to 0017 (the TV chip display routine); R2 (stack pointer) is initialized to 06FF (top of pushdown stack); R3 points to 0399, the beginning of the program. R3 becomes the program counter with an SEP instruction.

The subroutines occupy two areas of memory, beginning and end, while the main program occupies the middle of used memory. The reason for this is that OUTCH, the character generator routine, was orig-

1		
I	0000-0014	Initialization routine.
I	0015-0032	Display routine.
I	0033-00FF	Part of OUTCH subroutine. Outputs a single character to screen.
ı	0100-01FF	Screen display buffer.
I	0200-02B3	Table of character patterns.
I	02B4-0398	Rest of OUTCH.
I	0399-0644	Disassembler Main. Displays mnemonics of 1802 op codes.
ı	0645-064F	GETHEX subroutine. Inputs and displays one byte from hex keypad.
ı	0650-065B	OUTMSG subroutine. Outputs an entire character.
I	065C-0668	OUTDGT subroutine. Converts single hex digit to ASCII.
I	0669-06FF	Stack.
I	0700-071F	Table of 3N mnemonics.
ı	0720-075F	Table of 7N mnemonics.
١	0760-078F	Table of CN mnemonics.

Table 1. Breakdown of memory used by Disassembler.

Register Use

DMA pointer for TV display chip.

Pointer to interrupt routine to service display chip.

Pointer to stack (push-down from 06FF).

Program counter.

Not used. Not used.

Not used.

Pointer to 3N, 7N, CN, FN instruction mnemonics.

Pointer to OUTDGT.

Pointer to GETHEX.

Pointer to OUTCH. Pointer to OUTMSG.

End address of segment to be disassembled.

Start address of segment to be disassembled.

Shift counter used by OUTCH (for spacing between characters).

Points to address of next screen character display area (used by OUTCH).

Table 2. Use of registers.

0790-07BF Table of FN mnemonics.

inally a stand-alone program capable of accepting and displaying input from an ASCII keyboard. The other subroutines evolved as the main program was being written. OUTCH resides in addresses 0033 through 0398, while GETHEX, OUTMSG and OUTDGT occupy addresses 0645 through 0668. The disassembler main program resides in memory 0399 through 0644. Some mnemonic tables occupy 0700 to 07BF, while other mnemonics needing special consideration are incorporated within the main program. Table 1 summarizes the memory breakdown.

Operating the Disassembler

Addresses 0000 through 0002 contain an LBR command to jump to the Elf monitor program. If another operating system is used, this instruction should be modified to contain the entry point address of that system.

After the program is loaded and the RUN switch is turned on, control is passed to the disassembler by jumping to address 0003. With the Elf II, this is accomplished by entering 00, 00, 03. Other systems may require different entries.

When the disassembler executes, it will display an input prompting message. Enter the desired starting address, high byte first, then low byte. As each digit is entered, it is simultaneously displayed on the hex display. When the correct byte is showing, press the input button to enter the byte. After the two-byte starting address is entered, key in the two-byte ending address in the same manner. Press the input button again to display the first line of code. Continue pressing the input button to display each subsequent line of data. When the ending address is reached, END will appear. Pressing the input button once more will bring back the first prompting message. From this point, another set of starting and ending addresses may be entered.

In all, this program occupies 2K RAM, addressed 0000 through 07BF. If this is unsatisfactory, unload the entire program to tape and reload to a higher location (with the Elf; other systems may not allow this). Of course, the table and subroutine pointers, as well as the Long Branch instructions, would need to be modified in this situation.

Table 1 is a breakdown of the memory occupied by the disassembler. Table 2 shows how each register is used. Listing 1 is the disassembler program. Listing 2 is the table of dot patterns used by OUTCH to generate characters. Listing 3 is the instruction mnemonics that are displayed on the screen.

This disassembler was de-

signed for anyone with a minimum Elf with 4K RAM memory and TV or display monitor. If you have access to a hard-copy device, OUTCH may be modified or replaced by a routine to output to that device. In any case, I hope that this program proves useful to anyone who utilizes it. I find it an excellent debugging tool, easily more readable than my haphazard coding sheets.

Netronics has recently released their own assembler, as well as a disassembler. However, the Netronics version sells for \$20, a price that I consider prohibitive. Their version requires that the user buy their video display board (or at least a

ADDR	DA	ТА															
0200	02	52	24	22	14	00	00	00	22	66	17	27	22	00	10	42	
0210	22	62	67	72	57	15	44	47	62	63	75	54	55	73	06	20	
0220	02	57	71	52	22	52	00	01	56	11	54	41	55	02	27	25	
0230	55	55	54	45	52	15	46	65	55	54	25	54	55	12	42	50	
0240	02	02	22	20	22	27	07	02	52	62	56	62	23	40	40	11	
0250	55	64	56	64	72	16	45	55	65	62	25	55	22	22	22	00	
0260	00	07	74	40	22	52	20	04	52	41	71	54	51	02	27	20	
0270	47	55	54	45	52	55	44	45	42	51	25	56	52	42	12	05	
0280	02	02	21	30	14	00	40	40	27	76	16	24	22	44	10	42	
0290	75	62	67	43	57	25	74	47	41	56	27	24	52	73	06	02	
02A0	00	01	00	00	00	01	01	01	01	01	00	00	00	01	00	00	
02B0	01	00	01	00													

Listing 2. Character pattern table for OUTCH subroutine.

ADDR	DA				0.4	00	00	0.4	00							
0700	52	51	5A	50	31	32	33	34	20	4E	4E	4D	4E	4E	4E	4
0710	20	20	20	5A	20	20	20	20	20	51	5A	00	31	32	33	34
0720	52	44	4C	53	41	53	52	53	53	4D	52	53	41	53	52	53
0730	45	49	44	54	44	44	53	4D	41	41	45	45	44	44	53	4[
0740	54	53	58	58	43	42	48	42	56	52	51	51	43	42	48	42
0750	20	20	41	44	20	20	52	20	20	4B	20	20	49	49	4C	49
0760	42	42	42	42	4E	53	53	53	53	42	42	42	53	53	53	53
0770	52	51	5A	50	4F	4E	4E	4D	4B	4E	4E	4D	49	4B	4B	50
0780	20	20	20	5A	50	51	5A	20	50	51	5A	00	45	51	5A	5/
0790	4C	4F	41	58	41	53	53	53	4C	4F	41	58	41	53	53	53
07A0	44	52	4E	4F	44	44	48	4D	44	52	4E	52	44	44	48	41
07B0	58	20	44	52	44	20	52	20	49	49	49	49	49	49	4C	49
07C0	Use	er sp	ace	beg	ins											

Listing 1. 1802 Disassembler.

0000 0003 0004	CO FO OO 90 Bl	START	LBR GHI PHI	FOOO RO R1	Jump to Elf monitor. Get current addr hi. Current addr into Rl hi.
0005	F8 17		LDI	"17"	Rl points to
0007	Al		PLO	R1	TV chip routine.
0008	F8 OF		LDI	"06"	R2 points to stack (06FF).
000A	B2		PHI	R2	.
000B	F8 FF		LDI	120.00	-
OOOD	A2		LDI	R2 "03"	R3 points to MAIN (0399).
000E	F8 03		PHI	R3	ity pointes to main (05/7).
0010	B3 F8 99		LDI	119911	_
0011	A3		PLO	R3	_
0014	D3		SEP	R3	Jump to MAIN.
0015	72	RETURN	LDXA	-	Restore data register.
0016	70		RET		Return to caller.
0017	22	INTRPT	DEC	R2	Save data register.
0018	7 8		SAV		Save R(P), R(X).
0019	22		DEC	R2	·
OOLA	52		STR	R2	D-3
001B	C4		NOP		Delay to sync.
0010	C4		NOP NOP		
001D 001E	C4 F8 01		LDI	"01"	RO points to display area.
0020	BO		PHI	RO	no points to display area.
0021	F8 00		LDI	110011	-
0023	AO		PLO	RO	- <u>-</u>
0024	80	OUT8	GLO	RO	Output 8 display bytes.
0025	E2	0010	SEX	R2	-
0026	E2		SEX	R2	_
0027	20		DEC	RO	
0028	AO		PLO	RO	-
0029	E2		SEX	R2	-
002A	20		DEC	RO	<u> </u>
002B	AO		PLO	RO	-
002C	E2		SEX	R2	-
002D	20		DEC	RO	T-1
002E	AO 01		PLO	RO OTTM P	TO MIT abd a made dama
002F	3C 24		BN1	OUT8	If TV chip not done,
0031	30 15		BR	RETURN	branch to get 8 more.
0033	12	RTN2	INC	R2	Else done, return. Restore stack pointer.
0034	70		RET	112	Return to caller.
0035	AE	OUTCH	PLO	RE	Save character.
0036	E2		SEX	R2	
0037	8E		GLO	RE	Get character.
0038	FF OD		SMI	"OD"	Character = CR?
003A	3A 4E		BNZ	TESTLF	No, branch.
003C	F8 01		LDI	"01"	RF points to end of
003E	BF		PHI	RF	display area.
003F	F8 FF		LDI	"FF"	-
0041	AF	DIANU	PLO	RF RF	- C
00/12	2F F8 00	BLANK	DEC LDI	"00"	Screen minus 1.
0043	5F		STR	RF	Store 8 spaces on screen.
0046	8F		GLO	RF	Done? Screen blank?
0047	3A 42		BNZ	BLANK	No, branch and continue.
0049	F8 09	SHIFT9	LDI	"09"	Yes, set shift counter
004B	BE		PHI	RE	to maximum.
004C	30 33		BR	RTN2	Branch to return.
OOLE	8E	TESTLF	GLO	RE	Get character.
004F	FF OA		SMI	"OA"	Character = LF?
0051	3A 72		BNZ	TEST20	No, branch.
0053	8F FF CO		GLO	RF "CO"	Get screen addr.
0054 0056	C3 O3 3A		SMI LBDF	SCROLL	Bottom of screen? Yes, scroll up screen.
30,0	אל לט לס		וטטו	COROLL	ico, scroii up screen.

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	8F		GLO	RF	Get screen addr.
005A	FA OF 3A 68		ANI BNZ	"OF" BEGINL	Mask upper bits. Beginning of line?
005C 005E	8F		GLO	RF	RF point to next line.
005F	FC 08		ADI	"08"	-
0061	AF		PLO	RF	÷
0062	8F	NEWLN	GLO	RF	-
0063	FC 28 AF		ADI PLO	#28" RF	
0065 0066	30 49		BR	SHIFT9	Branch to set shift, rtn.
0068	1F	BEGINL	INC	RF	Line addr plus 1.
0069	8F		GLO	RF	Get screen addr.
006A	FA OF		ANI	"08"	Mask upper bits off. Test addr. Begin a line?
006C 006E	FF 08 32 62		BZ	NEWLN	Yes, branch.
0070	30 68		BR	BEGINL	No, loop and continue.
0072	8E	TEST20	GLO	RE	Get character.
0073	FF 20		SMI	"20"	Test character. Valid?
0075	3B 33		BM GLO	RTN2 RE	No, less than 20 hex. Get character.
0077 0078	8E FF 60		SMI	"60"	Valid character?
007A	33 33		BPZ	RTN2	No, gtr than 5F hex.
007C	9D		GHI	RD	Yes, save RD.
007D	73		STXD	DD	-
007E	8D 73		GLO	RD	-
080	90		GHI	RC	Save RC.
0081	73		STXD		
0082	8C		GLO	RC	
0083	73		STXD	DD	Save RB.
0084	9B 73		STXD	RB	ave in.
0086	8B		GLO	RB	-
0087	73		STXD		-
0088	8E		GLO	RE	Get character.
0089 008A	52 F8 02		STR	R2 "02"	Push onto stack. RC points to character
008C	BC OZ		PHI	RC	pattern table.
008D	F8 FO		LDI	"FO"	
008F	AC		PLO	RC	
0090	02		TDN	R2	Get character.
0091	F6 22		SHR	R2	Character/2. Save value/2.
0092	52		STR	R2	-
0094	8C		GLO	RC	RC point to character
0095	FL		ADD	DO	pattern.
0096	AC 12		PLO	RC R2	R2 point to saved char.
0098	F8 05		LDI	05	RD = line counter.
009A	AD		PLO	RD	- 1
009B	02	GETPAT	LDN	R2	Get character.
009C 009D	F6 33 A6		SHR	RTPAT	Character/2. If odd, branch.
009F	OC NO		LDN	RC	Else even, load char pattern.
OAOO	F6		SHR		Shift upper nybble
00A1	F6		SHR		into lower nybble.
00A2 00A3	F6 F6		SHR		-
	30 A9		BR	OUTPAT	Branch to output pattern.
00A4			TTORT	RC	Get character pattern.
00A6	OC	RTPAT	LDN		
00A6 00A7	FA OF		ANI	"OF"	Mask off upper bits.
00A6 00A7 00A9	FA OF 22	RTPAT	ANI	R2	Mask off upper bits. Save char pattern.
00A6 00A7	FA OF		ANI		
OOA 6 OOA 7 OOA 9 OOA A OOA B OOA C	FA OF 22 52 22 52		ANI DEC STR DEC STR	R2 R2 R2 R2	Save char pattern.
OOA 6 OOA 7 OOA 9 OOA A OOA B OOA C OOA D	FA OF 22 52 22 52 9E		ANI DEC STR DEC STR GHI	R2 R2 R2 R2 RE	Save char pattern
OOA6 OOA7 OOA9 OOAA OOAB OOAC OOAD	FA OF 22 52 22 52 52 9E FF O1		ANI DEC STR DEC STR GHI SMI	R2 R2 R2 R2 RE "O1"	Save char pattern.
OOA 6 OOA 7 OOA 9 OOA A OOA B OOA C OOA D	FA OF 22 52 22 52 9E FF Ol AE 33 BA		ANI DEC STR DEC STR GHI	R2 R2 R2 R2 RE	Save char pattern
OOA6 OOA7 OOA9 OOAA OOAD OOAC OOAD OOAE OOBO OOB1 OOB3	FA OF 22 52 22 52 9E FF O1 AE 33 BA 8E		ANI DEC STR DEC STR GHI SMI PLO BPZ GLO	R2 R2 R2 R2 RE "Ol" RE TSTCNT	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left
OOA6 OOA7 OOA9 OOAA OOAD OOAC OOAD OOB1 OOB3 OOB1	FA OF 22 52 22 22 9E FF Ol AE 33 BA 8E FC O8	OUTPAT	ANI DEC STR DEC STR GHI SMI PLO BPZ GIO ADI	R2 R2 R2 R2 RE "O1" RE TSTCNT RE "O8"	Save char pattern.
OOA6 OOA7 OOA9 OOAA OOAD OOAC OOAD OOAE OOBO OOB1 OOB3	FA OF 22 52 22 52 9E FF O1 AE 33 BA 8E	OUTPAT	ANI DEC STR DEC STR GHI SMI PLO BPZ GLO	R2 R2 R2 R2 RE "Ol" RE TSTCNT	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left
OCA 6 OCA 7 OCA 9 OCA A OCA B OCA C	FA OF 22 52 52 9E FFF O1 AE 33 BA 8E FC 08 AE C1	OUTPAT	ANI DEC STR DEC STR GHI SMI PLO BPZ GLO ADI PLO INC NOP	R2 R2 R2 RE "O1" RE TSTCNT RE "O8" RE	Save char pattern.
OCA 6 COA 7 COA 9 COA A COA B COA C COA D COA B COA C COA D COA B COB C C COB C C C C C C C C C C C C C C C C C C C	FA OF 22 52 52 52 52 52 52 64 64 64 64 64 64 64 64 64 64 64 64 64	OUTPAT SHIFT8	ANI DEC STR DEC STR GHI SMI PLO BPZ GIO ADI PLO INC NOP	R2 R2 R2 R2 RE "O1" RE TSTCNT RE "O8" RE	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1.
OCA 6 OCA 7 OCA 9 OCA A OCA B OCA C OCA D OCA C OCA D OCA C OCA D OCA C	FA OF 22 52 52 52 52 56 FF 01 AE 8E FC 08 AE LF CLL 6E	OUTPAT	ANI DEC STR DEC STR GHI SMI PLO BPZ GLO ADI PLO INC NOP NOP	R2 R2 R2 RE "OI" RE TSTCNT RE "O8" RE	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available.
OCA 6 COA 7 COA 9 COA A COA B COA C COA D COA B COA C COA D COA B COB C C COB C C C C C C C C C C C C C C C C C C C	FA OF 22 52 52 52 52 52 52 64 64 64 64 64 64 64 64 64 64 64 64 64	OUTPAT SHIFT8	ANI DEC STR DEC STR GHI SMI PLO BPZ GIO ADI PLO INC NOP	R2 R2 R2 R2 RE "O1" RE TSTCNT RE "O8" RE	Save char pattern.
OCA 6 OCA 7 OCA 9 OCA A OCA B OCA C OCA D OCA C OCA D OCA C OCA D OCA C OCA D OCA C	FA OF 22 52 52 52 FF O1 AE 33 BA 8E FC O8 AE CLL CLL SE 32 B3	OUTPAT SHIFT8	ANI DEC STR GHI SMI PLO BPZ GLO ADI PLO INC NOP NOP GLO BZ	R2 R2 R2 RE "O1" RE TSTCNT RE "O8" RE RF	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available.
OOA 6 OOA 7 OOA 9 OOA OOA OOA OOA OOA OOA OOA OOA OOA OOB OOB	FA OF 22 52 52 52 52 52 65 66 67 60 68 68 68 68 68 68 68 68 68 68 68 68 68	OUTPAT SHIFT8	ANI DEC STR DEC STR GHI PLO BPZ GLO ADI PLO INC NOP GLO BZ GLO SMI PLO	R2 R2 R2 R2 RE "O1" RE TSTCNT RE "O8" RE RF RE RF	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character?
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGB OGB 1 OGB C OGB	FA OF 22 22 22 52 9E FF 01 AE 33 BA 8E FC 08 AE 1F CLL 8E 32 B3 B6 FF 03 AE 33 EL	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR GHI SMI PLO BPZ GLO ADI PLO INC NOP NOP OF GLO SMI PLO SMI PLO BZ GLO SMI PLO BZ GLO SMI PLO BPZ	R2 R2 R2 RE RE "O1" RE TSTCNT RE RE RF RE RF RE SHIFT8 RE "O3" RE SPACE3	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGB C	FA OF 22 52 52 52 52 56 FF O1 AE 33 BA 6E FC O8 AE 1F CLL 6E 32 B3 6E 32 B3 AE 33 EL 02	OUTPAT SHIFT8	ANI DEC STR DEC STR GHI PLO BPZ GLO NOP NOP GLO SMI PLO SMI PLO BZ GLO SMI PLO	R2 R2 R2 R2 RE "O1" RE TSTCNT RE "O8" RE RF RE RF	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGB OGB 1 OGB C OGB	FA OF 22 22 22 52 9E FF 01 AE 33 BA 8E FC 08 AE 1F CLL 8E 32 B3 B6 FF 03 AE 33 EL	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR GHI SMI PLO BPZ GLO ADI PLO INC NOP NOP OF GLO SMI PLO SMI PLO BZ GLO SMI PLO BZ GLO SMI PLO BPZ	R2 R2 R2 RE RE "O1" RE TSTCNT RE RE RF RE RF RE SHIFT8 RE "O3" RE SPACE3	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces.
OGA 6 OGA 7 OGA 9 OGA 0 OGA 0 OGA 0 OGA 0 OGA 0 OGB 0	FA OF 222 522 522 52 9E FF O1 AEE FC O8 AE 1F CU 8E 32 B3 AE FF O3 AE 33 E4 O2 F6 52 1E	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR GHI SMI PLO GHO ADI INC NOP GLO BZ GLO SMI PLO SMI SHR STR STR	R2 R2 R2 RE "O1" RE TSTCNT HE "08" RE RF RF RE SHIFT8 RE SHIFT8 RE RF RE RF RE RE RF RE	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGB C OGB OGB C OGB C OGB OGB C OGB OGB C OGB OGB C OGB OGB OGB C OGB OGB OGB OGB C OGB OGB OGB OGB OGB C OGB OGB OGB OGB OGB OGB OGB C OGB	FA OF 222 522 522 528 FFF O1 AE 33 BA BE FC O8 AE 32 B3 BE 32 B3 AE 33 E4 502 FFF O3 AE 33 B4 B5 B5 B6 B7 B7 B8	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR DEC STR GHI SMI PLO ADI INC NOP NOP NOP SMI PLO BZ GLO BPZ GLO SMI PLO BZ GLO SMI PLO BC BC BPZ GLO BC GLO SMI FLO BC	R2 R2 R2 RE RE "O1" RE TSTCNT RE "O8" RE RF RE SHIFT8 RE SPACE3 R2 R2 R2 RE RE	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts dome?
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGA C	FA OF 22 22 52 52 9E FF O1 AE 8E FC O8 AE 1F CLL 8E 8E FF O3 AE C3 C3	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR GHI SMI PLO GHO INC NOP GLO SMI PLO INC SMI PLO INC SMI SPZ GLO INC GLO SMI STR INC GLO GLO SMI SHR STR INC GLO GLO GLO SMI	R2 R2 R2 RE RE TSTCNT RE TSTCNT RE RF RE SHIFT8 RE SHIFT8 RE SPACE3 R2 R2 RE RE SHLPAT	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Cet nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts dome? No, branch and shift again.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGB C OGB OGB C OGB C OGB OGB C OGB OGB C OGB OGB C OGB OGB OGB C OGB OGB OGB OGB C OGB OGB OGB OGB OGB C OGB OGB OGB OGB OGB OGB OGB C OGB	FA OF 222 522 522 522 526 FF O1 AE 33 BA BC FC O8 AE 1F CLL BE 32 B3 AE 33 EL 33 EL 33 C3 FF 52 C3 FF	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR DEC STR GHI SMI PLO ADI INC NOP NOP NOP SMI PLO BZ GLO BPZ GLO SMI PLO BZ GLO SMI PLO BC BC BPZ GLO BC GLO SMI FLO BC	R2 R2 R2 RE RE "O1" RE TSTCNT RE "O8" RE RF RE SHIFT8 RE SPACE3 R2 R2 R2 RE RE	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts dome?
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGB C	FA OF 222 522 522 522 526 FF O1 AE 8E FF O8 AE 1F CLL 8E 8E FF O3 AE FF O3 AE FF O3 AE CL FF O3 AE AE FF O3 AE AE AE FF O3 AE	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR GHI SMI PLO GHO INC NOP GLO SMI PLO SMI STR INC GLO STR	R2 R2 R2 RE RE TSTCNT RE TSTCNT RE RF RE SHIFT8 RE SPACE3 R2 R2 RE RE RF RF	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Cet nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts dome? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte.
OGA 6 OGA 7 OGA 9 OGA 0 OGB 0	FA OF 222 522 522 522 52 52 652 652 652 652 6	OUTPAT SHIFT8 TSTCNT	ANI DEC GHI SMI PIO GHO INC NOP GLO BZ GLO SMI PIO INC NOP GLO BZ LDN SHR INC GLO BPZ LDN STR INC GLO ENZ LDN OR STR INC	R2 R2 R2 RE "O1" RE TSTCNT HE "08" RE RF RF RE SHIFT8 RE SHIFT8 RE RE RE SHIFT8 RE SHIFT8 RE RF RF RF RF RF RF	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGB C	FA OF 222 522 522 522 522 526 FF O1 AE 33 BA 6E FC O8 AE 1F CLL 6E 32 B3 AE 33 E4 02 F6 52 F6 F6 52 F6	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR DEC STR DEC STR SMI PLO BPZ GLO ADI INC NOP GLO BZ GLO BPI SMI PLO BZ GLO BPI LDN SHR STR CLO BOR STR STR CLO BOR STR STR STR STR CLO BOR STR STR STR STR STR CLO BOR STR STR STR STR STR CLO BOR STR STR STR STR STR STR STR STR STR ST	R2 R2 R2 RE RE "O1" RE TSTCNT RE "O8" RE RF RE SHIFT8 RE SPACE3 R2 R2 R2 RE RE SHLPAT RF	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter.
OGA 6 OGA 7 OGA 9 OGA 0 OGB 0	FA OF 222 522 522 522 52 52 652 652 652 652 6	OUTPAT SHIFT8 TSTCNT	ANI DEC GHI SMI PIO GHO INC NOP GLO BZ GLO SMI PIO INC NOP GLO BZ LDN SHR INC GLO BPZ LDN STR INC GLO ENZ LDN OR STR INC	R2 R2 R2 RE "O1" RE TSTCNT HE "08" RE RF RF RE SHIFT8 RE SHIFT8 RE RE SHIFT8 RE SPACE3 R2 R2 R2 RE RE RE RF RF RF	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGB C	FA OF 222 522 522 522 522 526 FF O1 AE 8E 6C1 8E 32 B3 8E 6C1 8E 32 B3 AE 6C1 8E 32 B3 AE 6C1 8E 32 B3 AE 6C1 6C1 8E 32 B3 AE 6C1 6C1 8E 6C1 6C1 8E 6C2 6C3 6C3 6C6 6C7 6C7 6C7 6C7 6C7 6C7 6C7 6C7 6C7	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR DEC STR GHI SMI PLO ADI INC NOP GLO BZ GLO SMI PLO BZ GLO BPZ GLO	R2 R2 R2 RE RE "O1" RE TSTCNT RE "O8" RE RF RE SHIFT8 RE SPACE3 R2 R2 RE RE SHLPAT RF	Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGA C OGA D OGB C OGB OGB C OGB	FA OF 222 522 522 522 526 FF O1 AE 33 BA 8E FF O8 AE 1F CLL 8E B3 B3 B4 B6 FF O3 AE AE	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR GHI SMI PLO GHO INC NOP GLO SMI PLO SMI SPZ GLO INC GLO SMI SPZ GLO INC GLO SMI STR INC GLO SMI STR INC GLO GLO STR INC GLO GLO STR INC GLO GLO STR INC OR INC OR INC OR INC INC	R2 R2 R2 RE RE "O1" RE TSTCNT RE "O8" RE RF RE SHIFT8 RE SPACE3 R2 R2 RE SPACE3 R7 RE RF RE RF RE RE RF RE RE RF RE	Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter.
OGA 6 OGA 7 OGA 9 OGA 0 OGB 0	FA OF 222 522 522 522 522 52 52 65 66 67 60 68 68 68 68 68 68 68 68 68 68 68 68 68	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR DEC STR GHI SMI PIO ADI INC NOP GLO SMI PIO SMI PIO SMI PIO SMI PIO SMI PIO SMI PIO STR INC CHI ADI PIO INC	R2 R2 R2 RE "O1" RE TSTCNT HE "08" RE RF RF RF RF RF RF RF RP	Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGA C OGA D OGB C OGB OGB C OGB	FA OF 222 522 522 522 522 526 FF 01 AE BA 8E FC 08 AE C1 6E B3 BE 03 AE E4 6C1 8E B3 BE C3 6F 6C 52 EB 8E C3 6F 6C 52 EB	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR GHI SMI PLO GHO INC NOP GLO SMI PLO SMI SPZ GLO INC GLO SMI SPZ GLO INC GLO SMI STR INC GLO SMI STR INC GLO GLO STR INC GLO GLO STR INC GLO GLO STR INC OR INC OR INC OR INC INC	R2 R2 R2 RE RE "O1" RE TSTCNT RE "O8" RE RF RE SHIFT8 RE SPACE3 R2 R2 RE SPACE3 R7 RE RF RE RF RE RE RF RE RE RF RE	Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter.
OGA 6 OGA 7 OGA 9 OGA 0 OGB 0	FA OF 222 522 522 522 522 52	OUTPAT SHIFT8 TSTCNT	ANI DEC STR DEC STR GHI SMI PIO GHO INC NOP GIO SMI PIO STR INC CHI ADI PIO INC INC CHI PIO STR INC	R2 R2 R2 RE RE "O1" RE TSTCNT RE "O8" RE RF RE SHIFT8 RE SPACE3 R2 R2 RE RE RF	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter. Get original dot pat. Shift out displayed
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGB C OGB OGB C OG	FA OF 222 522 522 522 526 FF O1 AE BA 8E FC O8 AE FF O3 AE BA 8E O3 AE BA 8E O3 AE C3 FF OF FF O1 FF O1 AE DA C3 C3 FF O2 FF O4 AE D2 C2 C3 C3 C3 C4 C4 C5 C5 C6 C7	OUTPAT SHIFT8 TSTCNT SHLPAT	ANI DEC STR DEC STR SMI PLO SMI PLO INC NOP GLO BZ GLO SMI PLO SMI PLO BZ GLO SMI PLO BZ GLO SMI PLO BPZ GLO BPZ GLO SMI PLO BPZ GLO SMI PLO BPZ GLO SMI PLO BPZ LDN SHR STR CGLO STR INC CGLO STR INC CGLO STR INC CGLO STR INC STR I	R2 R2 R2 RE RE "O1" RE TSTCNT RE "08" RE RF RE SHIFT8 RE SPACE3 R2 R2 RE RE SHLPAT RF	Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter. Get original dot pat.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGA C OGA D OGA C OGA D OGA C OGB C OGB C OGB C OGC C	FA OF 222 522 522 522 526 FF O1 AE 8E FC O8 AE 1F CLL 8E 8E FF O3 AE C3 FF O4 AE C3 FF O5 AE C5 FF O5 AE C5 C5 C5 C6 C7	OUTPAT SHIFT8 TSTCNT SHLPAT	ANI DEC STR DEC STR DEC STR GHI SMI PLO GHO INC NOP GLO SMI PLO SMI STR INC GLO GLO STR INC GLO LDN STR INC LDN STR INC LDN STR INC LDN STR INC STR IN	R2 R2 R2 R2 RE "01" RE TSTCNT RE "08" RE RF RE SHIFT8 RE SPACE3 R2 R2 RE SHLPAT RF	Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter. Get original dot pat. Get original dot pat. Shift out displayed bits.
OGA 6 OGA 7 OGA 9 OGA A OGA B OGA C OGA D OGA C OGA D OGB C OGB OGB C OG	FA OF 222 522 522 522 526 FF O1 AE BA 8E FC O8 AE FF O3 AE BA 8E O3 AE BA 8E O3 AE C3 FF OF FF O1 FF O1 AE DA C3 C3 FF O2 FF O4 AE D2 C2 C3 C3 C3 C4 C4 C5 C5 C6 C7	OUTPAT SHIFT8 TSTCNT SHLPAT	ANI DEC STR DEC STR SMI PLO SMI PLO INC NOP GLO BZ GLO SMI PLO SMI PLO BZ GLO SMI PLO BZ GLO SMI PLO BPZ GLO BPZ GLO SMI PLO BPZ GLO SMI PLO BPZ GLO SMI PLO BPZ LDN SHR STR CGLO STR INC CGLO STR INC CGLO STR INC CGLO STR INC STR I	R2 R2 R2 RE RE "O1" RE TSTCNT RE "08" RE RF RE SHIFT8 RE SPACE3 R2 R2 RE RE SHLPAT RF	Save char pattern. Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter. Get original dot pat. Shift out displayed
OGA 6 OGA 7 OGA 9 OGA 0 OGB 0	FA OF 222 522 522 522 522 526 FF 01 A88 65 66 67 688 32 68 68 66 67 688 68 68 68 68 68 68 68 68 68 68 68 68	OUTPAT SHIFT8 TSTCNT SHLPAT	ANI DEC STR DEC STR DEC STR GHI SMI PIO ADI INC NOP GLO SMI PIO SMI PIO SMI PIO SMI PIO SMI PIO SMI PIO STR INC CHI ADI PIO STR INC CHI ADI PIO STR INC CHI PI	R2 R2 R2 RE "01" RE TSTCNT HE "08" RE RF RF RF RF RF RE SHIFT8 RE SHIFT8 RE SHIFT8 RE RE "03" RE RE RP RE RP RE RP RE RP RE RP RE	Account for space between characters. Branch if any shifts left. Else no shifts left Adjust nbr shifts available. Line addr plus 1. Get nbr shifts available. If zero, branch to adjust. Room for a full character? Yes, see if exactly 3 spaces. No, less than 3 spaces. Shift pattern left. Save adjusted pattern. Shift counter plus 1. All shifts done? No, branch and shift again. Yes, store pattern on screen. OR pattern to screen byte. Store byte. Line addr plus 1. Adjust shift counter. Get original dot pat. Get original dot pat. Shift out displayed bits.

Get screen addr.

0059 8F

OODE	OF		LDN	RF	Yes, put char on
OODF	Fl		OR		screen.
OOEO	5F		STR	RF	Bootens for most bits
00E1	2F 30 F0		DEC BR	RF NXTDOT	Restore for next bits.
OOE4	32 ED	SPACE3	BZ	STRPAT	Branch if no shifts.
00E6	02	SHL2	LDN	R2	Else shift char pat
OOE7	FE		SHL		as needed.
00E8	52		STR	R2	Ann shifts loft?
OOE9	2E 8E		DEC	RE RE	Any shifts left?
OOEB	3A E6		BNZ	SHL2	Yes, branch.
OOED	OF	STRPAT	LDN	RF	No, store char pat
OOEE	Fl		OR		on screen.
OOEF	5F	MAMDOW	STR	RF	Next dot line down.
OOFO OOF1	8F FC O8	NXTDOT	GLO ADI	RF	wext dot line down.
00F3	AF		PLO	RF	_
OOF4	8C		GLO	RC	Get next dot pattern
00F5	FC 20		ADI	"20"	in table.
OOF7	AC		PLO	RC	Post and steels point on
00F8 00F9	12 12		DEC	R2 R2	Restore stack pointer.
OOFA	CO 02 B4		LBR	CONTNU	Branch to cont process.
OOFD	CL		NOP		
OOFE	CH		NOP		
OOFF	C4		NOP		
0100	- Olff				Screen display area.
0200 -					Character dot table.
02B4	9E	CONTNU	GHI	RE	Get original shifts.
02B5	FF 02		SMI	"02"	Room for full char?
02B7	33 BA		BPZ	TSTLN	Yes, branch.
02B9 02BA	2F 2D	TSTLN	DEC	RF RD	No, restore screen. All char lines on
O2BB	8D	10114	GLO	RD	screen?
O2BC	CA 00 9B		LBNZ	GETPAT	No, branch.
02BF	8F		GLO	RF	Restore char addr.
0200	FF 28		SMI	"28"	-
0202	AF 9E		PLO	RF RE	Account for char
0204	FF OL		SMI	"OL"	and space.
0206	BE		PHI	RE	-
02C7	33 CE		BPZ	SKPADJ	Branch if any shifts
0209	1F		INC	RF	left, else adjust
O2CA O2CB	9E FC 08		GHI ADI	RE "08"	char addr & shifts.
O2CD	BE		PHI	RE	-
O2CE	F8 03	SKPADJ	LDI	"03"	RB points to BIGCH
O2DO	BB		PHI	RB	subroutine.
02D1	F8 67		LDI	"67"	-
02DJ	AB 02		PLO	RB R2	Get character.
02D5	FF LE		SMI	"TE"	= "N"?
02D7	C2 O3 O8		LBZ	LAST	Yes, branch.
O2DA	02	TESTM	IDN	R2	No, get character.
O2DB	FF LD		SMI	"4D"	= "M"?
O2DD O2DF	3A E8 F8 AO		BNZ LDI	TEST#	No, branch.
02E1	AC		PLO	RC	Yes, RC points to rest of "M".
02E2	79		MARK		Save R(P), R(X).
02E3	DB		SEP	RB	Jmp subroutine BIGCH.
05E7	22		DEC	R2	Restore stack pointer.
02E5 02E8	CO O3 O8	TEST#	LBR	LAST R2	Get character.
02E9	FF 23	IESIM	SMI	"23"	det character.
O2EB	3A FC				= "#"?
O2ED			BNZ	TESTW	= "#"? No, branch.
	F8 A5		IDI	TESTW "A5"	No, branch. RC points to part
O2EF	AC		IDI PLO	TESTW	No, branch. RC points to part of "#" character.
02EF 02F0 02F1			IDI	TESTW "A5"	No, branch. RC points to part of "#" character. Save P, X.
02F0	AC 79		IDI PLO MARK	TESTW "A5" RC	No, branch. RC points to part of "#" character.
02F0 02F1 02F2 02F3	AC 79 DB 22 F8 AF		IDI PLO MARK SEP DEC LDI	TESTW "A5" RC RB R2 "AF"	No, branch. RC points to part of "#" character. Sawe P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest
02F0 02F1 02F2 02F3 02F5	AC 79 DB 22 F8 AF AC		IDI PLO MARK SEP DEC IDI PLO	TESTW "A5" RC RB R2	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#".
02F0 02F1 02F2 02F3 02F5 02F6	AC 79 DB 22 F8 AF AC 79		IDI PLO MARK SEP DEC LDI PLO MARK	TESTW "A5" RC RB R2 "AF" RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X.
02F0 02F1 02F2 02F3 02F5	AC 79 DB 22 F8 AF AC		IDI PLO MARK SEP DEC IDI PLO	TESTW "A5" RC RB R2 "AF"	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#".
02F0 02F1 02F2 02F3 02F5 02F6 02F7 02F8 02F9	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE		IDI PLO MARK SEP DEC LDI PLO MARK SEP DEC LBR	TESTW "A5" RC RB R2 "AF" RC RB R2 ENDCH	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack.
02F0 02F1 02F2 02F3 02F5 02F6 02F7 02F8 02F9 02FC	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE 02	TESTW	IDI PLO MARK SEP DEC LDI PLO MARK SEP DEC LBR LDN	TESTW "A5" RC RB R2 "AF" RC RB R2 EDDCH R2	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character.
02F0 02F1 02F2 02F3 02F5 02F6 02F7 02F8 02F9 02FC 02FD	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE 02 FF 57	TESTW	IDI PLO MARK SEP DEC LDI PLO MARK SEP DEC LBR LDN SMI	TESTW "A5" RC RB R2 "AF" RC RB R2 EDDCH R2 "57"	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"?
02F0 02F1 02F2 02F3 02F5 02F6 02F7 02F8 02F9 02FC 02FD 02FF	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE 02 FF 57 CA 03 OE	TESTW	IDI PLO MARK SEP DEC LDI PLO MARK SEP DEC LBR LDN SMI LENZ	TESTW "A5" RC RB R2 "AF" RC RB R2 ENDCH R2 ENDCH R2 ENDCH R2 ENDCH	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch.
02F0 02F1 02F2 02F3 02F5 02F6 02F7 02F8 02F9 02FC 02FD	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE 02 FF 57	TESTW	IDI PLO MARK SEP DEC LDI PLO MARK SEP DEC LBR LDN SMI	TESTW "A5" RC RB R2 "AF" RC RB R2 EDDCH R2 "57"	No, branch. RC points to part of "#" character. Sawe P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Sawe P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "#".
02F0 02F1 02F2 02F5 02F6 02F7 02F8 02F9 02FC 02FD 02FF 0302 0304 0305	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE 02 FF 57 CA 03 OE F8 AA AC 79	TESTW	IDI PLO MARK SEP DEC LDI PLO MARK SEP DEC LBR LDN SMI LBNZ LDI LDD MARK	TESTW "A5" RC RB R2 "AF" RC RB R2 ENDCH R2 ENDCH R2 "57" ENDCH "AA" RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X.
02F0 02F1 02F2 02F3 02F5 02F6 02F7 02F8 02F9 02FC 02FD 02FF 0302 0304 0305 0306	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE O2 FF 57 CA 03 OE F8 AA AC 79 DB	TESTW	IDI PLO MARK SEP DEC LDI PLO MARK SEP DEC LBN SMI LENZ LDI PLO MARK SEP	TESTW "A5" RC RB R2 "AF" RC RB R2 "FT" RC RB R2 RB R2 RB R2 RB RC RB RC RB	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH.
02F0 02F1 02F2 02F3 02F5 02F6 02F7 02F8 02F9 02FC 02FD 02FF 0302 0304 0305 0306 0307	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE 02 FF 57 CA 03 OE F8 AA AC 79 DB 22 CO 05 DB 20 DB 22 CO 05 DB 20 DB		IDI PIO MARK SEP DEC IDI MARK SEP DEC LIDI LIBR LIDN SMI LENZ LIDI PLO MARK SEP DEC DEC	TESTW "A5" RC RB R2 "AF" RC RB R2 ENDCH R2 "57" ENDCH "AA" RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack.
02F0 02F1 02F2 02F3 02F5 02F6 02F7 02F8 02F9 02FC 02FD 02FF 0302 0304 0305 0306	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE O2 FF 57 CA 03 OE F8 AA AC 79 DB	TESTW	IDI PLO MARK SEP DEC LDI PLO MARK SEP DEC LBN SMI LENZ LDI PLO MARK SEP	TESTW "A5" RC RB R2 "AF" RC RB R2 "FT" RC RB R2 RB R2 RB R2 RB RC RB RC RB	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH.
02F0 02F1 02F3 02F5 02F5 02F7 02F8 02F9 02FD 02FD 03O5 03O6 03O7 03O8	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE O2 FF 57 CA 03 OE F8 AA AC AC 79 DB 22 F8 AS AC 79 T9		IDI PIO MARK SEP DEC LDI MARK SEP LDO MARK SEP LIDI LBR LIDN SMI LIDI PLO MARK SEP DEC LIDI PLO MARK	TESTW "AG" RC RB R2 "AF" RC RB R2 "S7" ENDCH R2 "S7" ENDCH RC RB R2 "AS" RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to part of "W". Save P, X. Save P, X. Save P, X.
02F0 02F1 02F2 02F3 02F6 02F7 02F8 02FD 02FD 02FD 0305 0305 0306 0307 0308 030B 030B	AC 79 DB 22 F6 AF AC 79 DB 22 CO 03 OE O2 FF 57 CA 03 OE F8 AA AC 79 DB 22 F8 A5 AC 79 DB		IDI PIO MARK SEP DEC LIDI PIO MARK SEP DEC LBR LDN SMI LENZ LDI PIO MARK SEP DEC LOI MARK SEP	TESTW "A5" RC RB R2 "AF" RC RB R2 ENDCH R2 "57" ENDCH "AA" RC RB R2 RB RC RB	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Save P, X. Jmp subroutine BIGCH.
02F0 02F1 02F2 02F5 02F5 02F7 02F8 02F7 02FD 02FF 0305 0305 0306 0307 0308 030A 030B	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE FF 57 CA 03 OE F8 AA AC 79 DB 22 F8 AC 79 DB 22 AC 79 DB 22	LAST	IDI PIO MARK SEP DEC LIDI PIO MARK SEP DEC LIBR LIDI SMI LENZ LIDI PLO MARK SEP DEC LIDI MARK SEP DEC LIDI MARK SEP DEC	TESTW "AG" RC RB R2 "AF" RC RB R2 "S7" ENDCH R2 "S7" ENDCH RC RB R2 "AS" RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack.
02F0 02F1 02F2 02F3 02F6 02F6 02F7 02FB 02FC 02FD 03OL 03OL 03O6 03OA 03OB 03OC 03OB	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE O2 FF 57 CA 03 OE F8 AA AC 79 DB 22 F8 AS AC 79 DB 22 F8 AC 60 CO FF F5 AC AC 79 DB CO F6 AC 79 DB		IDI PLO MARK SEP DEC LIDI PLO MARK SEP DEC LBR LBN LBN SMI LBN SMI LBN SEP DEC LDI PLO MARK SEP DEC LDI PLO MARK SEP DEC LDI RARK SEP DEC LDI PLO MARK	TESTW "A5" RC RB R2 "AF" RC RB R2 ENDCH R2 "57" ENDCH "AA" RC RB R2 RB RC RB	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. Inc stack.
02F0 02F1 02F2 02F5 02F5 02F7 02F8 02F7 02FD 02FF 0305 0305 0306 0307 0308 030A 030B	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE FF 57 CA 03 OE F8 AA AC 79 DB 22 F8 AC 79 DB 22 AC 79 DB 22	LAST	IDI PIO MARK SEP DEC LIDI PIO MARK SEP DEC LIBR LIDI SMI LENZ LIDI PLO MARK SEP DEC LIDI MARK SEP DEC LIDI MARK SEP DEC	TESTW "A5" RC RB R2 "AF" RC RB R2 ENDCH R2 "57" ENDCH "AA" RC RB R2 RB RC RB	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack.
02F0 02F1 02F2 02F3 02F6 02F6 02F7 02FC 02FD 030L 0305 030M 030B 030C 030B 030C 030B 030C 030B 030C 030B	AC 79 DB 22 F8 AF AC 79 DB 22 CO 03 OE O2 FF 57 CA 03 OE F8 AA AC 79 DB 22 F8 AC 79 DB 22 CO 72 DB 22 CO 72 DB 22 CO 72 DB 22 CO 72 DB 72	LAST	IDI PLO MARK SEP DEC LIDI PLO MARK SEP DEC LIBN LINN SMI LENZ LIDI PLO MARK SEP DEC LIDI LINI LINI LINI LINI LINI LINI LINI	TESTW "A5" RC RB R2 "AF" RC RB R2 "S7" ENDCH R2 "S7" ENDCH RC RB R2 "A5" RC RB R2 RC RB R2 RC RB R2 RC RB R2 RC RB R2 RC RB R2 RC RB RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. Inc stack.
02F0 02F1 02F2 02F3 02F6 02F7 02F6 02F7 02FC 02FF 030L 0305 0306 0307 0308 030A 030A 030B 030C 030C 030D 030E 030F 0310 0311 0312	AC 799 DB 22 F6 AF AC 799 DB 22 CO 03 OE F6 AA AA AC 79 DB 22 F6 AC 79 DB 22 F6 AC 79 DB 22 AS BB F6 AC 79 BB	LAST	IDI PIO MARK SEP DEC LIDI PLO MARK SEP DEC LIBN SMI LIDN SMI LIDN SMI LIDN SMI LIDN SMI LIDN LIDN LIDN LIDN LIDN LIDN LIDN LID	TESTW "A5" RC RB R2 "AF" RC RB R2 ENDCH R2 "57" ENDCH "AA" RC RB R2 "A5" RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. Inc stack. Restore RB.
02F0 02F1 02F2 02F3 02F6 02F7 02F6 02F7 02FC 02FD 0305 0305 0306 0307 0308 030A 030B 030D 030B 030D 030D 030E 030I 0311 0311	AC 79 DB 22 CO 03 OE 02 FF 57 CA 03 OE F8 AA AC 79 DB 22 AS AC 79 DB 22 AS AC 79 DB 22 AS AC 79 DB 22 AB 72 AB 72 BB 72	LAST	IDI PIO MARK SEP DEC LIDI PIO MARK SEP DEC LIDI SMI LENZ LIDI PIO MARK SEP DEC LBR LIDI PIO MARK SEP DEC LIDI PIO MARK SEP DEC LIDI IDI PIO MARK SEP DEC LIDI IDI IDI IDI IDI IDI IDI IDI IDI ID	TESTW "A5" RC RB R2 "AF" RC RB R2 "ENDCH R2 "57" ENDCH "AA" RC RB R2 RB R2 RB R2 RB	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. Rc points to rest of "R". Save P, X. Restore stack. Rc points to rest of "R". Restore RB Restore RB.
02F0 02F1 02F2 02F3 02F6 02F7 02F6 02F7 02FC 02FF 030L 0305 0306 0307 0308 030A 030A 030B 030C 030C 030D 030E 030F 0310 0311 0312	AC 799 DB 22 F6 AF AC 799 DB 22 CO 03 OE F6 AA AA AC 79 DB 22 F6 AC 79 DB 22 F6 AC 79 DB 22 AS BB F6 AC 79 BB	LAST	IDI PIO MARK SEP DEC LIDI PLO MARK SEP DEC LIBN SMI LIDN SMI LIDN SMI LIDN SMI LIDN SMI LIDN LIDN LIDN LIDN LIDN LIDN LIDN LID	TESTW "A5" RC RB R2 "AF" RC RB R2 "S7" ENDCH R2 "S7" ENDCH RC RB R2 "A5" RC RB R2 RC RB R2 RC RB R2 RC RB R2 RC RB R2 RC RB R2 RC RB RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. Inc stack. Restore RB.
02F0 02F1 02F2 02F3 02F6 02F7 02F6 02F7 02FC 02FD 0305 0306 0307 0308 030A 030B 030B 030C 030B 030B 030B 030B 030B	AC 79 DB 22 CO 03 OE 60 AA AC 79 DB B2 AF AA AC 79 DB B2 AC 79 DB B2 AC 79 BB AC 79 AB AC 79 AB 72 AC 72 AC 72 BC BC FC AC 79 BC AC 79 BB 72 AC 72 BC BC FC AC 79 BC	LAST	IDI PIO MARK SEP DEC LIDI PIO MARK SEP DEC LIDI SEP DEC LIDI LENZ LIDI PIO MARK SEP DEC LIDI PIO MARK SEP DEC LIDI PIO MARK SEP DEC LIDI DEC LIDI PIO MARK SEP DEC LIDI IDIA PIO LENZ LIDIA PIO LIDIA PIIO LIDIA PIII PIII PIII PIII LIDIA PIII PIII PIII PIII LIDIA PIII PIII PIII PIII PIII PIII PIII	TESTW "A5" RC RB R2 "AF" RC RB R2 "ENDCH R2 "57" ENDCH "AA" RC RB R2 RB R2 RB R2 RB	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. Restore RE
02F0 02F1 02F2 02F3 02F6 02F7 02F6 02F7 02FC 03FC 03OL 030F 030A 030B 030C 030B 030C 030B 030C 0311 0312 0311 0315 0311	AC 79 DB 22 CO 03 OE 02 F8 AA AC 79 DB B2 C2 CA 03 OE F8 AA AC 79 DB C2 CA	LAST	IDI PIO MARK SEP DEC IDI PIO MARK SEP DEC LBR IDI IDI SMI LENZ IDI PIO MARK SEP DEC IDI IDI PIO MARK SEP DEC IDI IDI IDI PIO MARK SEP DEC IDI IDI IDI IDI IDI IDI IDI IDI IDI ID	TESTW "A5" RC RB R2 "AF" RC RB R2 "S7" ENDCH R2 "S7" RC RB R2 "A5" RC RB R2 RB RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore RC. Restore RB Restore RC Restore RD.
02F0 02F1 02F2 02F3 02F6 02F7 02F6 02F7 02FC 02FC 030F 030S 030S 030A 030B 030C 030C 030C 030D 030D 031D 0311 0312 0313 0315 0316 0316 0316	AC 799 DB 22 CO 03 OE 02 FF 57 CA 03 OE FR AA AA AC 79 DB 22 FR A5 AC 79 DB 22 AC 79 BB 72 AC 72 BC AD AD	LAST	IDI PIO MARK SEP DEC LIDI PLO MARK SEP DEC LIBN LIDI LIDN SMI LENZ LIDI LENZ LIDI PLO MARK SEP DEC LIDI LENZ LIDI PLO LENZ LIDI PLO LIDI LIDXA PHI	TESTW "A5" RC RB R2 "AF" RC RB R2 ENDCH R2 "57" ENDCH "AA" RC RB R2 "A5" RC RB R2 RB RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "\"? No, branch. RC points to part of "\". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "\". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "\". Save P, X. Jmp subroutine BIGCH. Restore RC. Restore RB Restore RC Restore RC.
02F0 02F1 02F2 02F3 02F6 02F7 02F6 02F7 02FC 03FC 03OL 030F 030A 030B 030C 030B 030C 030B 030C 0311 0312 0311 0315 0311	AC 79 DB 22 CO 03 OE 02 F8 AA AC 79 DB B2 C2 CA 03 OE F8 AA AC 79 DB C2 CA	LAST	IDI PIO MARK SEP DEC IDI PIO MARK SEP DEC LBR IDI IDI SMI LENZ IDI PIO MARK SEP DEC IDI IDI PIO MARK SEP DEC IDI IDI IDI PIO MARK SEP DEC IDI IDI IDI IDI IDI IDI IDI IDI IDI ID	TESTW "A5" RC RB R2 "AF" RC RB R2 "S7" ENDCH R2 "S7" RC RB R2 "A5" RC RB R2 RB RC	No, branch. RC points to part of "#" character. Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "#". Save P, X. Jmp subroutine BIGCH. Restore stack. Get character. = "W"? No, branch. RC points to part of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore stack. RC points to rest of "W". Save P, X. Jmp subroutine BIGCH. Restore RC. Restore RB Restore RC Restore RD.

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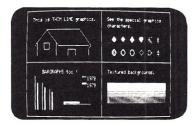
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031B					
	8F		GLO	RF	Get char addr.
0310	FA OF		ANI	#OF#	Mask off upper bits.
031E	52		STR	R2	Save for later test.
031F	FF 07		SMI	110711	End of a line?
0321	32 28		BZ	EOL	Yes, branch.
	02		LDN	R2	No, get character.
0323			SMI	"OF"	End of a line?
0321	FF OF			TSTEOP	No, branch.
0326	3A 34	DOT	BNZ		
0328	9E	EOI,	GHI	RE	Yes, get shifts.
0329	FF 06		SMI	110611	Room for another char?
032B	33 34		BPZ	TSTEOP	Yes, branch.
032D	8F		GLO	RF	Get char addr.
032E	FC 29		ADI	"29"	Char addr = new line.
0330	AF		PLO	RF	•
0331	F8 09	SHF9	LDI	"09"	Nbr shifts = 9
0333	BE		PHI	RE	-
0334	8F	TSTEOP	GLO	RF	Get char addr.
0335	FF C7		SMI	"C7"	End of page?
0337	CB 00 33		LBM	RTN2	No, branch to return.
033A	22	SCROLL	DEC	R2	Yes, scroll up 1 line.
	F8 01	COLODE	LDI	"01"	RF points to 1st line
033B			PHI	RF	to be scrolled up.
033D	BF			113011	to be berefied up.
033E	F8 30		LDI		-
0370	AF		PLO	RF	2 1 2 1
0341	OF	BYTEUP	LDN	RF	Get byte
0342	52		STR	R2	save it.
0343	8F		GLO	RE	RF points to upper
0344	FF 30		SMI	"30"	line.
0346	AF		PLO	RF	-
0347	02		LDN	R2	Get saved byte.
0348	5F		STR	RF	Store on upper line.
0349	8F		GLO	RF	RF points to lower
03LA	FC 30		ADI	"30"	line.
034C	AF		PLO	RF	
			INC	RF	RF points to next byte.
03PD	1F			RF	All lines scrolled?
O3LE	8F		GLO		wit Times serotted:
03LF	FF E8		SMI	uE8n	No bear-b
0351	3B 41		BM	BYTEUP	No, branch.
0353	F8 CO		LDI	"CO"	Yes, RF points to last
0355	AF	No. Tonadar	PLO	RF	line on screen.
0356	F8 00	SPACEL	LDI	"OO"	Blank out last line
0358	5F		STR	RF	Store space on screen.
0359	1F		INC	RF	Point to next addr.
035A	8F		GLO	RF	Get screen addr.
035B	FF FE		SMI	"FE"	End of screen?
035D	3B 56		BM	SPACE1	No, branch.
035F	F8 CO		LDI	"CO"	Yes, RF points to
	AF-		PLO	RF	last line on acreen.
0361			INC	R2	Restore stack pointer.
0362	12				Branch to restore max
0363	30 31		BR	SHF9	nbr of shifts.
00/5	12	DUMA	INC	R2	Restore stack pointer.
0365		RTN3	RET	112	Return to caller.
0366	70	DTCCII		DO.	
0367	E2	BIGCH	SEX	R2	R2 = stack pointer.
0368	9E		GHI	RE	Any shifts left?
0369	3A 71		BNZ	SHFT-1	Yes, branch.
036B	1F		INC	RF	No, acreen addr + 1.
0360	F8 07		LDI	"07"	Set nbr of shifts max.
036E	BE		PHI	RE	-
036F	30 75		BR	SETRD	The second secon
0371	9E	SHFT-1	GHI	RE	Acct for last part of
0372	FF Ol		SMI	"01"	big character.
0374	BE		PHI	RE	-
0375	F8 05	SETRD	LDI	"05"	RD is char line cntr.
0377	AD		PLO	RD	-
0378	9E	OUTBIG	GHI	RE	Initialize shft cntr.
0379			PLO	RE	
9317	AE			140	-
037A			DEC	R2	Stack - 1.
	AE				Stack - 1. Get last part of char.
037A 037B	AE 22		DEC	R2	Get last part of char. Save.
037A	АЕ 22 ЦС		DEC LDA	R2 RC	Get last part of char.
037A 037B 037C	AE 22 40 52		DEC LDA STR	R2 RC R2	Get last part of char. Save. Any shifts left? No, branch.
037A 037B 037C 037D	AE 22 4C 52 8E	SHFBIG	DEC LDA STR GLO	R2 RC R2 RE	Get last part of char. Save. Any shifts left? No, branch.
037A 037B 037C 037D 037E 0380	AE 22 4C 52 8E 32 87	SHFBIG	DEC LDA STR GLO BZ	R2 RC R2 RE STRBIG	Get last part of char. Save. Any shifts left?
037A 037B 037C 037D 037E	AE 22 4C 52 8E 32 87	SHFBIG	DEC LDA STR GLO BZ LDN	R2 RC R2 RE STRBIG	Get last part of char. Save. Any shifts left? No, branch. Shift last part
037A 037B 037C 037D 037E 0380 0381 0382	AE 22 4C 52 8E 32 87 02 FE	SHFBIG	DEC LDA STR GLO BZ LDN SHL	R2 RC R2 RE STRBIG R2	Get last part of char. Save. Any shifts left? No, branch. Shift last part
037A 037B 037C 037D 037E 0380 0381 0382 0383	AE 22 40 52 8E 32 87 02 FE 52 2E	SHFBIG	DEC LDA STR GLO BZ LDN SHL STR DEC	R2 RC R2 RE STRBIG R2 R2 RE	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char.
037A 037B 037C 037D 037E 0380 0381 0382 0383	AE 22 4C 52 8E 32 87 02 FE 52 2E 8E	SHFBIG	DEC LDA STR GLO BZ LDN SHL STR DEC GLO	R2 RC R2 RE STRBIG R2 R2 RE RE	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char Done?
037A 037B 037C 037D 037E 0380 0381 0382 0383 0384 0385	AE 22 4C 52 8E 32 87 02 FE 52 2E 8E 3A 80		DEC LDA STR GLO BZ LDN SHL STR DEC GLO BNZ	R2 RC R2 RE STRBIG R2 R2 RE RE SHFBIG	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. - Done? No, branch.
037A 037B 037C 037D 037E 0380 0381 0382 0383 0384 0385 0387	AE 22 4C 52 8E 32 87 02 FE 52 2E 8E 80 0F	SHFBIG	DEC LDA STR GLO BZ LDN SHL STR DEC GLO BNZ LDN	R2 RC R2 RE STRBIG R2 R2 RE RE	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char Done? No, branch. Yes, store char last
037A 037B 037C 037D 037E 0380 0381 0382 0383 0384 0385 0387	AE 22 52 8E 32 87 02 FE 52 2E 8E 3A 80 0F		DEC LDA STR GLO BZ LDN SHL STR DEC GLO BNZ LDN OR	R2 RC R2 RE STRBIG R2 RE RE RE SHFBIG RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. - Done? No, branch.
037A 037B 037C 037D 037E 0380 0381 0382 0383 0384 0385 0387 0388	AE 22 LC - 52 BE 87 O2 FE 88 BE 87 S2 S6		DEC LDA STR GLO BZ LDN SHL STR DEC GLO BNZ LDN OR STR	R2 RC R2 RE STRBIG R2 R2 RE RE SHFBIG RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char
037A 037B 037C 037C 037E 0380 0381 0382 0383 0384 0385 0387 0388 0389 0388	AE 22 8E 32 87 02 FE 52 2E 8E 80 0F F1 57		DEC LDA STR GLO BZ LDN SHL STR DEC GLO BNZ LDN OR STR GLO	R2 RC R2 RE STRBIG R2 R2 RE RE RE RF RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char Done? No, branch. Yes, store char last on screen RF points to next
037A 037B 037D 037D 0380 0381 0382 0383 0384 0385 0387 0388 0388	AE 22		DEC LDA STR GLO BZ LDN SHL STR DEC GLO BNZ LDN OR STR GLO ADI	R2 RC R2 RE STRBIG R2 R2 RE RE SHFBIG RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char
037A 037B 037C 037D 037E 0380 0381 0382 0383 0384 0385 0388 0389 0388	AE 222 BE 47 O2 FE 52 2E 88 80 OF F1 5F FC O8 AF		DEC LDA STR GLO BZ LDN SHL STR GEO BNZ LDN OR STR GLO ADI PLO	R2 RC R2 RE STRBIG R2 RE RE SHFBIG RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line.
037A 037B 037D 037D 0381 0382 0383 0384 0385 0388 0389 0388 0388 0388 0388	AE 22		DEC LDA GLO BZ LDN SHL STR DEC GLO BNZ LDN OR STR GLO INC	R2 RC R2 RE STRBIG R2 RE RE RE RF RF RF RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char
037A 037B 037D 037D 0380 0381 0383 0381 0385 0388 0389 0388 0389 038B 038B	AE 22		DEC LIDA STR GLO BZ LIDN SHL STR DEC GLO BNZ LIDN OR STR GLO ADI INC DEC	R2 RC R2 RE STRBIG R2 R2 RE RE SHFBIG RF RF "08" RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line.
037A 037B 037C 037D 037E 0380 0381 0382 0383 0385 0387 0388 0389 0388 038B 038B 038B	AE 222 8E 87 02 FE 52 2E 8E 8A 80 OFF FT 8F FC 08 AF 12 2D 8D		DEC LDA STR GLO BZ LDN SHL STR DEC GLO BNZ LDN OR STR GLO ADI PLO INC GLO GLO	R2 RC R2 RE STRBIG R2 RE RE SHFBIG RF RF RF RF RF RF RF RF RF RF RF RF RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen?
037A 037B 037C 037D 0382 0381 0382 0383 0384 0385 0387 0388 0389 0388 0388 0389 0388 0389 0389	AE 22 BE 87 02 EE 88 80 OF F1 8F FC 08 AF 12 2D 3A 78		DEC LDA GLO BZ LDN SHL STR GLO BNZ LDN STR GLO BNZ LDN OR STR GLO ADI INC DEC GLO BNZ	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF RF RF RF RF RF RP RD RD OUTBIG	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char
037A 037B 037D 037D 038D 0381 0382 0383 0385 0387 0388 0389 038B 038B 038B 038B 038B 038B	AE 22 8E 32 87 002 FE 22 8E 3A 80 00F F1 5F FC 08 AF 12 2D 8B 8F		DEC LDA GLO BZ LDN SHL STR DEC GLO BNZ LDN OR GLO ADDI INC DEC GLO BNZ DEC GLO ADDI OR DEC GLO DEC GLO	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF RF RF RF ROB" RF ROUTBIG RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen?
037A 037B 037C 037D 0382 0381 0382 0383 0384 0385 0387 0388 0389 0388 0388 0389 0388 0389 0389	AE 22 BE 87 02 EE 88 80 OF F1 8F FC 08 AF 12 2D 3A 78		DEC LDA GLO BZ LDN SHL STR GLO BNZ LDN STR GLO BNZ LDN OR STR GLO ADI INC DEC GLO BNZ	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF RF RF RF RF RF RP RD RD OUTBIG	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char
037A 037B 037C 037D 0380 0381 0382 0383 0381 0385 0388 0388 0388 038B 038B 038B 038B 038B	AE 22 8E 87 02 FE 8E 80 0F F1 8F FC 08 AF 12 2D 3A 78 8F FF 28 AF		DEC LDA STR GLO BZ LDN SHL STR DEC GLO STR DEC GLO ADI PLO DEC GLO BNZ GLO BNZ GLO SKI	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF RF RF RF RF RP RD OUTBIG RF RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. - Done? No, branch. Yes, store char last on screen. RF points to next char line. - Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF.
037A 037B 037C 037D 038D 0381 0385 0385 0388 0389 0388 0388 0389 038B 038B 038B 038B 038B	AE 222 8E 87 02 FE 52 2E 8E 8AF 06		DEC LDA STR GLO BZ LDN SHL STL GLO BNZ LDN OR STR GLO INC GLO BNZ GLO BNZ GLO BNZ GLO SMI	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF "08" RF R2 RD RD RD RD RD RF "26" RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char
037A 037B 037C 037D 0380 0381 0382 0383 0381 0385 0388 0388 0388 038B 038B 038B 038B 038B	AE 22 8E 87 02 FE 8E 80 0F F1 8F FC 08 AF 12 2D 3A 78 8F FF 28 AF		DEC LDA STR GLO BZ LDN SHL STR DEC GLO STR DEC GLO ADI PLO DEC GLO BNZ GLO BNZ GLO SKI	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF RF RF RF RF RP RD OUTBIG RF RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. - Done? No, branch. Yes, store char last on screen. RF points to next char line. - Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF.
037A 037B 037C 037D 0380 0381 0382 0383 0381 0385 0388 0388 0388 0388 0388 0388 0389 0391 0391 0391 0391	AE 22	STRBIG	DEC LDA STR GLO BZ LDN SHL STR GLO BNI GLO BNI OR STR GLO ADI PLO DEC GLO BNI DEC GLO SMI DEC GLO BNI BNI BNI BR	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF "08" RF R2 RD RD RD RD RD RF "26" RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. FF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return.
037A 037B 037C 037D 0380 0381 0382 0381 0385 0386 0388 0388 0388 0388 0388 0388 0389 0391 0391 0396 0397	AE 22	STRBIG	DEC LDA STR GLO BZ LDN SHL STL GLO BNZ LDN OR STR GLO ADI PLO INC GLO BNZ GLO	R2 RC RE STRBIG R2 RE RE RE RE RF RF "08" RF RF "08" RF RP "08" RF RP "08" RF RP	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX.
037A 037B 037C 037D 0380 0381 0382 0383 0381 0385 0388 0388 0388 0388 0388 0389 0391 0391 0391 0391 0391 0391 0393	AE 22	STRBIG	DEC LDA STR GLO BZ LDN SHL DEC GLO BNZ LDN OR GRIC ADDI DEC GLO BNZ	R2 RC RE STRBIG R2 RE RE RE RE RE RF RF RF RF RF RF RF RP RD OUTBIG RF RT RT RT RT RD RD RF RT RT RT RT RT RD RD RF RT	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX.
037A 037B 037C 037D 038C 0381 0382 0383 0385 0388 0388 0388 0388 038B 038B 038B 038B	AE 22	STRBIG	DEC LDA STR GLO BZ LDN SHL STR GLO BNZ GLO BNZ LDN OR STR GLO ADI PLO DEC GLO BNZ GLO SMI DEC GLO SMI DEC GLO SMI LDI PLO BNZ GLO BNZ GLO BNZ GLO BNZ GLO BNZ GLO BR LDI LDI LDI	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF "OB" RF R2 RD RD RD RD RD RD RF RT "28" RF RF RF "78" "78" "78" "78" "78" "78" "78" "78	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX.
037A 037B 037C 037D 0380 0381 0385 0381 0385 0388 0388 0388 0388 0388 0388 0388	AE 22	STRBIG	DEC LDA STR GLO BZ LDN SHL DEC GLO ENZ LDN OR GLO ADI DEC GLO BNZ GLO	R2 RC RE STRBIG R2 RE RE RE RE RF RF "08" RF RF "08" RF RP "08" RF RP "08" RF RP "08" RF RP RP "08" RF RP RP "08" RF RP RP RP "08" RP RP RP "146" RP	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX.
037A 037B 037C 037D 0380 0381 0382 0383 0381 0385 0388 0388 0388 0388 0388 0389 0391 0391 0391 0391 0392 0392 0398	AE 222 8E 87 32 87 32 87 52 2E 8E 8 80 0F F1 2 8D 78 8F F2 8D 78 8F FF 28 8F FF 28 8F FF 28 8F 65 65 65 65 66 69 9F8 46 A9 06 BB	STRBIG	DEC LDA STR GLO BZ LDN SHL STR GLO BNZ LDN GLO BNZ LDN OR STR GLO BNZ LDN OR STR GLO SMI PLO BNZ GLO SMI PLO SMI PLO SMI PLO SMI PLO LDI PHO L	R2 RC R2 RE STRBIG R2 RE RE RE RF RF RF RF RF RF RF RP RD OUTBIG RF RTN3 "O6" R9 "146" R9	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX.
037A 037B 037C 037D 0380 0381 0385 0381 0385 0388 0388 0388 0388 0388 0388 0388	AE 22	STRBIG	DEC LDA STR GLO BZ LDN SHL STR GLO BNZ GLO BNZ LDN OR STR GLO ADI PLO DEC GLO BNZ GLO SMI DEC GLO SMI PLO BNZ GLO SMI PLO BNZ GLO LDI PLO BR LDI PLO LDI PLO LDI PHI	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF RF "O8" RF R7 RO RD RD RD RD RD RF RT "28" RF RT RF RF RT RF	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX. RB points to OUTMSG.
037A 037B 037C 037D 038C 0381 0382 0383 0385 0388 0388 0388 0388 0388 0388	AE 222 BE 40 SE 80 OFF FC 08 AF 12 2D BB FF 86 65 66 BB BB FF 87 SE 88 BB 86 SE 86 S	STRBIG	DEC LDA STR GLO BZ LDN SHL STR GLO BNZ LDN OR STR GLO BNZ LDN OR STR GLO BNZ LDN OR STR GLO SMI PLO BNZ GLO SMI PLO LDI PLO LDI PHI LDI PHI LDI PHI LDI LDI	R2 RC RE STRBIG R2 RE RE RE RE RF RF RF "08" RF RF "08" RF RP "08" RF RP RD RD RD RD RD RD RD RT "28" RF "28" RF RT "28" RF RT "28" RF RT RT "06" RP "146" RP "06" RP	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX. RB points to OUTMSG.
037A 037B 037C 037D 0380 0381 0382 0383 0381 0385 0388 0388 038B 038B 038B 038B 038B 0391 0391 0395 0396 0397 0396 0397	AE 22	STRBIG	DEC LDA STR GLO BZ LDN SHL DEC GLO ENZ LDN OR GLO ADI PLO DEC GLO BNZ	R2 RC R2 RE STRBIG R2 RE RE RE RF RF "08" RF RF "08" RF RP "08" RF RP "06" RP "146" RP "9" "16" RP RP "16" RP RP "16" RP	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX. RB points to OUTMSG.
037A 037B 037C 037D 0380 0381 0382 0383 0381 0385 0388 0388 0388 0388 0389 0391 0391 0391 0391 0391 0391 0391 039	AE 222 8E 87 32 87 32 87 88 80 0F F1 2 8 8F FF 28 8F FF 28 8F FF 8 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	STRBIG	DEC LDA STR GLO BZ LDN SHL STR GLO BNZ GLO BNZ LDN OR STR GLO ADI PLO DEC GLO BNZ GLO SMI DEC GLO BNZ GLO SMI LDI PLO LDI PLO LDI PLO LDI	R2 RC R2 RE STRBIG R2 RE RE RE RE RF RF RF "O8" RF R7 RO RD RO RO RO RF RT "28" RF RT "28" RF RT "28" RF RT "28" RF RT R9 "146" R9 "06" R9 "06" RB "53" RB	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX. RB points to OUTMSG.
037A 037B 037C 037D 0380 0381 0382 0381 0385 0388 0388 0388 0388 0388 0389 0391 0391 0391 0392 0391 0392 0391 0392 0391 0393 0391 0393 0393 0394 0393 0394 0395 0396 0397	AE 222 8E 87 32 87 32 87 88 80 0F F1 12 2D 8B 78 8F FF 28 8F FF 80 65 FF 80	STRBIG	DEC LDA STR GLO BZ LDN SHL STR GLO BNZ GLO BNZ LDN OR STR GLO ADI PLO DEC GLO BNZ GLO SMI DEC GLO BNZ GLO SMI LDI PLO LDI PLO LDI PLO LDI PLO LDI LDI PHI LDI	R2 RC R2 RE STRBIG R2 RE RE RE RE RF RF RF "O8" RF R7 RO RD RO RO RO RF RF RT "28" RF RT RS "06" RS "06" RS "146" RS "153" RB "53" RB "153" RB	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX. RB points to OUTCH.
037A 037B 037C 037D 0380 0381 0381 0383 0381 0388 0388 0388	AE 222 8E 87 02 FE 8E 80 OF FI 8F FC 08 AF 12 2D 3A 78 8F FF 8B 66 66 BB FF 8 9 06	STRBIG	DEC LIDA STR GLO BZ LIDN SHL DEC GLO ENZ LIDN OR GLO ADI PLO DEC GLO BNZ GLO BR LIDI PLO BR LIDI PHI LIDI	R2 RC R2 RE STRBIG R2 RE RE RE RF RF RF RF RF RF RP ROBU RF RD OUTBIG RF RT RT RP RT R9 "46" R9 "46" R9 "16" R9 "16" R9 "16" R9 "153" R8 "00" R8 R9 "153" R8 "00" R8	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX. RB points to OUTCH.
037A 037B 037C 037D 0380 0381 0382 0381 0385 0388 0388 0388 0388 0388 0389 0391 0391 0391 0392 0391 0392 0391 0392 0391 0393 0391 0393 0393 0394 0393 0394 0395 0396 0397	AE 222 8E 87 32 87 32 87 88 80 0F F1 12 2D 8B 78 8F FF 28 8F FF 80 66 65 65 66 66 67 88 8F 88 8F 88 8F 88 8F 88 8F 88 8F 88 88	STRBIG	DEC LDA STR GLO BZ LDN SHL STR GLO BNZ GLO BNZ LDN OR STR GLO ADI PLO DEC GLO BNZ GLO SMI DEC GLO BNZ GLO SMI LDI PLO LDI PLO LDI PLO LDI PLO LDI LDI PHI LDI	R2 RC R2 RE STRBIG R2 RE RE RE RE RF RF RF "O8" RF R7 RO RD RO RO RO RF RF RT "28" RF RT RS "06" RS "06" RS "146" RS "153" RB "53" RB "153" RB	Get last part of char. Save. Any shifts left? No, branch. Shift last part next to char. Done? No, branch. Yes, store char last on screen. RF points to next char line. Restore stack pointer. All of char on screen? No, branch. Else, yes, restore RF. Branch to return. R9 points to GETHEX. RB points to OUTCH.

O3AC	69		INPl		Turn on TV chip.
O3AD	79		MARK	DD.	Save R(P), R(X).
O3AE O3AF	OD LC LF	MSG1	SEP	RB	Jmp subroutine OUTMSG. Message 1:
03B2	41 44 20	11001			"LOAD START ADDR".
03B5	53 54 41				•
03B8	52 54 20				-
03BB 03BE	52 00				00 = end of message.
0300	22		DEC	R2	Control returns here,
				P.0	restore stack pointer.
0301	D9		SEP	R9	Jmp subroutine GETHEX. Input a byte.
0302	BD		PHI	RD	RD points to start addr.
0303	D9		SEP	R9	-
03CL	AD		PLO	RD	(-)()
0305	79		MARK	DD.	Save R(P), R(X).
0306	DB	Meco	SEP	RB	Jmp subroutine OUTMSG. Message 2:
03C7 03CA	4C 4F 41	MSG2			"LOAD END ADDR".
O3CD	LE LL 20				-
0300	41 44 44				-
03D3	52 00		DEC	R2	Restore R(X).
03D5 03D6	22 D9		DEC	R9	Jmp subroutine GETHEX.
03D7	BC		PHI	RC	RC points to end addr.
03D8	D9		SEP	R9	-
03D9	AC		PLO	RC	Sam P(P) P(Y)
O3DA O3DB	79 DB		MARK SEP	DB	Save R(P), R(X). Jmp subroutine OUTMSG.
O3DC	OD 41 44	MSG3	OLI	22	Message 3:
O3DF	44 52 20				"ADDR INST OP".
03E2	49 4E 53				•
03E5	54 20 20				-
03E8 03EB	4F 50 00		DEC	R2	Restore stack pointer.
O3EC	3F EC	KEYPR	BN4	KEYPR	Loop till key pressed.
O3EE	37 EE	KEYREL	B4	KEYREL	Loop till released.
03F0	8C		GLO	RC	Get end addr.
03F1	52 8D		STR	R2 RD	Save. Get curr code addr.
03F2 03F3	F7		SM	I.D	End addr - curr addr.
03F4	3B FA		BM	NOTEND	If not end, branch.
03F6	90		GHI	RC	Test addr hi for end.
03F7	52		STR	R2	-
03F8 03F9	9D F7		GHI	RD	-
O3FA	CB O4 OC	NOTEND	LBM	NUCODE	Not end, output another
					line of code.
O3FD	79	END	MARK	DD.	Save R(P), R(X).
O3FE O3FF	DB OA 45 4E	MSG14	SEP	RB	Jmp subroutine OUTMSG. Message 4: "END".
0402	44 00	11004			nessage 4: Ens .
					-
0404	22		DEC	R2	Restore R(X).
0404 0405	22 3F 05	KEYPR2	BN4	KEYPR2	Loop till key pressed.
0405 0407	22 3F 05 37 07	KEYPR2 KEYRL2	BN4 B4	KEYPR2 KEYRL2	Loop till key pressed. Loop till released.
0404 0405 0407 0409	22 3F 05 37 07 C0 03 99		BN4	KEYPR2	Loop till key pressed. Loop till released. Branch, start over.
0405 0405 0407 0409 0400 040E	22 3F 05 37 07		BN4 B4 LBR LDI MARK	KEYPR2 KEYRL2 MA IN	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P.
0404 0405 0407 0409 040C 040E 040F	22 3F 05 37 07 CO 03 99 F8 0A 79 DA		BN4 B4 LBR LDI MARK SEP	KEYPR2 KEYRL2 MA IN "OA"	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH.
0404 0405 0407 0409 040C 040E 040F 0410	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22		BNL BL LBR LDI MARK SEP DEC	KEYPR2 KEYRL2 MA IN "OA" RA R2	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack.
0404 0405 0407 0409 040C 040E 040F	22 3F 05 37 07 CO 03 99 F8 0A 79 DA		BN4 B4 LBR LDI MARK SEP	KEYPR2 KEYRL2 MA IN "OA"	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH.
0404 0405 0407 0409 040C 040E 040F 0410	22 3F 05 37 07 C0 03 99 F8 0A 79 DA 22 F8 06		BNL BL LBR IDI MARK SEP DEC LDI	KEYPR2 KEYRL2 MA IN "OA" RA R2 "O6"	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack.
0104 0105 0107 0109 010C 010E 010F 0110 0111 0113 0114	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 F8 06 B8 F8 5D A8		BN4 BL LBR LDI MARK SEP DEC LDI PHI LDI PLO	KEYPR2 KEYRL2 MA IN "OA" RA R2 "O6" R8 "5D" R8	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT.
0104 0105 0107 0109 010C 010F 0110 0111 0113 0111 0116 0117	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 F8 06 B8 F8 5D A8 9D		BNL BL LBR LDI MARK SEP DEC LDI PHI LDI PLO GHI	KEYPR2 KEYRL2 MA IN "OA" RA R2 "O6" R8	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCY. Restore stack. R6 points to OUTDGT Get curr addr hi.
0104 0105 0107 0109 010C 010E 010F 0110 0111 0113 0114	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 F8 06 B8 F8 5D A8		BN4 BL LBR LDI MARK SEP DEC LDI PHI LDI PLO	KEYPR2 KEYRL2 MA IN "OA" RA R2 "O6" R8 "5D" R8	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT.
0h0h 0h05 0h07 0h09 0h0E 0h0F 0h10 0h11 0h16 0h16 0h17 0h18	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 F8 06 B8 F8 5D A8 9D F6 F6 F6 F6		BNL BL LBR LDI MARK SEP DEC LDI PHI LDI PHO GHI SHR SHR	KEYPR2 KEYRL2 MA IN "OA" RA R2 "O6" R8 "5D" R8	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT Get curr addr hi. Left nybble into
0h0h 0h05 0h07 0h00 0h0E 0h0F 0h10 0h11 0h13 0h16 0h17 0h18 0h19 0h19	22 3F 05 37 07 CO 03 99 F8 0A 22 DA 22 F8 06 B8 F8 5D A8 PD F6 F6 F6 F6		BNL BL LBR LDI MARK SEP DEC LDI PHI LDI SHR SHR SHR SHR	KEYPR2 KEYRL2 MAIN. "OA" RA R2 "O6" R8 "5D" R8	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble.
0h0h 0h05 0h07 0h00 0h0C 0h0E 0h10 0h13 0h1h 0h18 0h19 0h18	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 F8 06 B8 F8 5D A8 9D F6 F6 F6 F6 F6 F6		BNL4 BL LBR LDI MARK SEP DEC LDI PHI LDI SHR SHR SHR SHR SEP	KEYPR2 KEYRL2 MAIN: "OA" RA R2: "O6" R8: "5D" R8: RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. - Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT.
0h0h 0h05 0h07 0h00 0h0E 0h0F 0h10 0h11 0h13 0h16 0h17 0h18 0h19 0h19	22 3F 05 37 07 CO 03 99 F8 0A 22 DA 22 F8 06 B8 F8 5D A8 PD F6 F6 F6 F6		BNL BL LBR LDI MARK SEP DEC LDI PHI LDI SHR SHR SHR SHR	KEYPR2 KEYRL2 MAIN. "OA" RA R2 "O6" R8 "5D" R8	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi.
0h0h 0h05 0h07 0h00 0h0C 0h0F 0h10 0h13 0h1h 0h16 0h17 0h18 0h19 0h1C 0h1D	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 F8 06 B8 F8 5D A8 9D F6 F6 F6 F6 F6 F6 F6 F6 F6 F6 D8		BNL4 BL LBR LDI MARK SEP DEC LDI PHI LDI SHR SHR SHR SHR SEP GHI ANI SEP	KEYPR2 KEYRL2 MAIN: "OA" RA R2 "O6" R8 "5D" R8 RD R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. - Get curr addr hi. Left nybble into right nybble Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT.
oholy ohos ohos ohos ohos ohos ohos ohil ohil ohil ohil ohil ohil ohil ohil	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 68 8 F8 5D A8 9D F6 F6 F6 F6 F6 F6 F6 B8 D8 BD FA OF BB BD BB BD BB BD BB BD BB BD BB BB BB		BNL BL LBR LDI MARK SEP DEC LDI PHI LDI PHO GHI SHR SHR SHR SHR SHR SHR SHR SHR SHR SHR	KEYPR2 KEYRL2 MAIN. "OA" RA R2 "O6" R8 "5D" R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low.
OhOld OhOS OhOS OhOS OhOS OhOS OhOS OhOS OhO	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 F8 06 B8 F8 5D A8 9D F6 F6 F6 F6 F6 F6 F6 F6 F6 F6 D8		BNL4 BL LBR LDI MARK SEP DEC LDI PHI LDI SHR SHR SHR SHR SEP GHI ANI SEP	KEYPR2 KEYRL2 MAIN: "OA" RA R2 "O6" R8 "5D" R8 RD R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. - Get curr addr hi. Left nybble into right nybble Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT.
oholy ohos ohos ohos ohos ohos ohos ohil ohil ohil ohil ohil ohil ohil ohil	22 3F 05 37 07 CO 03 99 F8 0A 22 F8 06 B8 F8 5D F6 F6 F6 F6 F6 F6 F6 F6 F6 F6		BNL BL LBR LDI MARK SEP DEC LDI PHI LDI SHR SHR SHR SHR SHR SEP GHI ANI SEP GLO SHR	KEYPR2 KEYRL2 MAIN: "OA" RA R2 "O6" R8 "5D" R8 RD R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low.
0h0h 0h05 0h07 0h09 0h06 0h106 0h10 0h11 0h113 0h11h 0h116 0h10 0h11B 0h11B 0h11C 0h11B 0h12C 0h11D 0h12C 0h12D 0h22C 0h23	22 3F 05 37 07 CO 03 99 F8 0A 22 F8 06 B8 5D F6 F6 F6 F6 F6 F6 F6 F6 F6 F6		BNL BL LBR LDI MARK SEP DEC LDI PIO GHI SHR SHR SHR SEP GLO SHR	KEYPR2 KEYL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr how. Left nybble into right.
OhOL OhOS OhOS OhOS OhOS OhOS OhII OhII OhII	22 37 07 CO 03 99 F8 0A 79 DA 22 CO 03 99 F8 06 B8 5D A8 9D F6		BNL BL LBR LDI MARK SEP DEC LDI PLO GHI SHR SHR SHR SEP GHI SEP GHI SEP GHI SEP SHR SEP SHR SEP SHR SHR SEP SHR SHR SEP SHR SEP SEP SEP SHR SEP SEP SHR SHR SEP SHR SHR SEP SHR SHR SHR SHR SHR SHR SHR SHR SHR SHR	KEYPR2 KEYNL2 MAIN. "OA" RA R2 "O6" R8 "5D" R8 RD R8 RD R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine outpgt.
01:04 01:05 01:07 01:09 01:06 01:01 01:13 01:14 01:16 01:17 01:18 01:18 01:19 01:10 01:10 01:10 01:20 01:21 01:23 01:21 01:25 01:25 01:25	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 6 B8 5D A8 9D F6		BNL BL BR LDR LDR LDR LDR LDI MARK SEP DEC LDI PLO GHI SHR	KEYPR2 KEYRL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Get curr addr low. Get curr addr low.
OhOL OhOS OhOS OhOS OhOS OhOS OhII OhII OhII	22 37 07 CO 03 99 F8 0A 79 DA 22 CO 03 99 F8 06 B8 5D A8 9D F6		BNL BL LBR LDI MARK SEP DEC LDI PLO GHI SHR SHR SHR SEP GHI SEP GHI SEP GHI SEP SHR SEP SHR SEP SHR SHR SEP SHR SHR SEP SHR SEP SEP SEP SHR SEP SEP SHR SHR SEP SHR SHR SEP SHR SHR SHR SHR SHR SHR SHR SHR SHR SHR	KEYPR2 KEYNL2 MAIN. "OA" RA R2 "O6" R8 "5D" R8 RD R8 RD R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine outpgt.
01:01 01:07 01:09 01:05 01:06 01:11 01:13 01:14 01:16 01:16 01:18 01:18 01:18 01:18 01:19 01:20 01:21 01:23 01:21 01:25 01:25 01:27 01:28 01:28	22 3F 05 37 07 CO 03 99 F8 0A 79 DA 22 06 B8 F8 5D A8 9D F6		BNL BL BR LDR LDR LDR LDR LDI MARK SEP DEC LDI PLO GHI SHR	KEYPR2 KEYL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "0F" R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Output a space.
01:04 01:05 01:07 01:09 01:05 01:01 01:13 01:14 01:18 01:19 01:18 01:19 01:18 01:19 01:18 01:19 01:19 01:21 01:22 01:23 01:25 01:26 01:27 01:28 01:28 01:28 01:28 01:28	22 3F 05 07 07 00 03 99 F8 0A 22 06 B8 5D F6		BNL BL LBR LDI MARK SEP DEC LDI LDI GHI SHR	KEYPR2 KEYL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Output a space. Save P, X.
OhOL OhOF OhOF OhOF OhII OhII OhII OhII OhII	22 3F 05 07 07 00 03 99 F8 0A 79 DA 22 06 B8 5D A8 9D F6		BNL BL LBR LDI MARK SEP DEC LDI PLO GHI SHR SHR SHR SHR SEP GLO SHR SHR SHR SEP GLO ANI SEP LDI MARK SEP LDI MARK	KEYPR2 KEYL2 MYAIN "OA" RA R2 "O6" R8 R5D" R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Save P, X. Jmp subroutine OUTCH.
01:04 01:05 01:07 01:09 01:05 01:01 01:13 01:14 01:18 01:19 01:18 01:19 01:18 01:19 01:18 01:19 01:19 01:21 01:22 01:23 01:25 01:26 01:27 01:28 01:28 01:28 01:28 01:28	22 3F 05 07 07 00 03 99 F8 0A 22 06 B8 5D F6		BNL BL LBR LDI MARK SEP DEC LDI LDI GHI SHR	KEY PR2 KEY L2 MA IN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD R8 RD R8 RD R8 RD R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Output a space. Save P, X.
OhOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLO	22 3F 05 07 07 00 03 99 F8 0A 79 DA 22 06 B8 5D A8 9D F6		BNL BL LBR LDI MARK SEP DEC LDI GHI SHR	KEYPR2 KEYRL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD "OF" R8 RD "OF" R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Save Curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Output a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch.
OhOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLO	22 3F 05 07 07 99 F8 0A 79 DA 22 06 B8 5D A8 9D F6		BNL BL BR LDR LDR LDR LDR LDR LDR LDR LDR LDR LD	KEYPR2 KEYRL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD TESTON	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Output a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P.
01:01 01:05 01:07 01:09 01:06 01:01 01:13 01:14 01:18 01:18 01:19 01:18 01:10 01:10 01:22 01:23 01:25 01:25 01:26 01:28	22 3F 05 07 99 F8 0A 22 06 B8 5D 9D F6	KEYRL2	BNL BL LBR LDI MARK SEP DEC LDI GHI SHR	KEY PR2 KEY L2 MA IN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD R8 RD R8 RD R8 RD R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Cet curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Cottput a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMSG.
OhOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLOLO	22 3F 05 07 07 99 F8 0A 79 DA 22 06 B8 5D A8 9D F6		BNL BL BR LDR LDR LDR LDR LDR LDR LDR LDR LDR LD	KEYPR2 KEYRL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD TESTON	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Output a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P.
01:01 01:07 01:09 01:06 01:07 01:13 01:13 01:14 01:17 01:18 01:19 01:10 01:10 01:12 01:20 01:21 01:23 01:24 01:28 01:38	22 3F 05 07 07 99 F8 0A 79 DA 222 05 DB 88 DD F6	KEYRL2	BNL BL BR LDR LDR LDR LDR LDI MARK SEP DEC LDI PIO GHI SHR	KEYPR2 KEYRL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD TESTON	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Cet curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Cottput a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMSG.
01:01 01:07 01:09 01:05 01:05 01:11 01:13 01:14 01:17 01:18 01:19 01:10 01:10 01:10 01:21 01:21 01:21 01:23 01:24 01:25 01:26 01:27 01:28 01:38	22 3F 05 07 99 79 0A 222 05 06 88 9D F6	MSG5	BNL BL BR LDR LDR LDR LDR LDR LDR LDR LDR LDR LD	KEYPR2 KEYR12 KE	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCY. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Ask off upper bits. Jmp subroutine OUTDGT. Output a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMGG. Message 5: "IDL". Restore stack.
01:01 01:07 01:07 01:09 01:05 01:01 01:13 01:14 01:17 01:18 01:19 01:10 01:10 01:10 01:21 01:21 01:21 01:21 01:25 01:21 01:25 01:21 01:25	22 3F 05 07 99 79 0A 222 06 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	KEYRL2	BNL BL BR LIDI MARK SEP DEC LIDI SHR	KEYPR2 KEYRL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD TESTON R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCY. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Output a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMGG. Message 5: "IDL". Restore stack.
01.01 01.05 01.07 01.09 01.06 01.01 01.13 01.14 01.18 01.18 01.19 01.10 01.20 01.21 01.23 01.24 01.25 01.25 01.25 01.26 01.27 01.28 01.28 01.29 01.29 01.29 01.20 01.31 01.33 01.34 01.38 01.38 01.38	22 3F 05 07 99 F8 0A 22 0 06 B8 5D A8 9D F6	MSG5	BNL BL BR LDR LDR LDR LDR LDR LDR LDR LDR LDDI PLO GHI SHR	KEYPR2 KEYR12 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD RE RD RD RE RD RD RE RD RD RE RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Cutput a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMSG. Message 5: "IDL". Restore stack. Point to next op code. Branch to output new line.
01:01 01:07 01:07 01:09 01:05 01:01 01:13 01:14 01:17 01:18 01:19 01:10 01:10 01:10 01:21 01:21 01:21 01:21 01:25 01:21 01:25 01:21 01:25	22 3F 05 07 99 79 0A 222 06 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	MSG5	BNL BL BR LIDI MARK SEP DEC LIDI SHR	KEYPR2 KEYRL2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD TESTON R8 RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCY. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Output a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMGG. Message 5: "IDL". Restore stack.
OLOMO OLOMO OLOMO OLOMO OLOMO OLIT OLITA O	22 3F 05 07 99 F8 0A 79 DA 22 6	MSG5	BNL BL BR LDR LDR LDR LDR LDR LDR LDR LDR LDR LD	KEYPR2 KEYR12 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD RE RD RD RE RD RD RE RD RD RE RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr how. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Cet curr addr low. Left nybble into right. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMGG. Message 5: "IDL". Restore stack. Point to next op code. Branch to output new line. Get op code. Branch to output new line. Get op code. Branch to output new line. Get op code.
0104 0107 0109 01006 01016 01113 01114 01120 01110 01110 01110 01120 01212 01213 01214 01226 0123 0124 0125 0126 0127 0128 0128 0128 0128 0128 0128 0128 0128	22 3F 05 07 99 79 0A 222 66 F6	MSG5	BNI BLI BR LIDI MARK SEP DEC LIDI SHR SHR SEP DEC LIDI SHR SHR SEP DEC LIDI SHR SHR SEP DEC NOP LIDN SHR SEP LIDN BNZ MARK SEP LIDN BNZ MARK SEP LIDN SHR	KEYPR2 KEYR12 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD RE RD RD RE RD RD RE RD RD RE RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr how. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Cet curr addr low. Left nybble into right. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMGG. Message 5: "IDL". Restore stack. Point to next op code. Branch to output new line. Get op code. Branch to output new line. Get op code. Branch to output new line. Get op code.
OLOMO OLOMO OLOMO OLOMO OLOMO OLOMO OLIT OLIT OLIT OLIT OLIT OLIT OLIT OLI	22 3F 05 07 99 79 0A 222 06 F6	MSG5	BNJ BL BR LBR LDI MARK SEP DEC LDI IDI SHR SHR SHR SEP GLO ANI SHR SEP LDI MARK SEP SHR SHR SHR SHR SHR	KEYPR2 KEYRA2 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD TESTON RB R2 RD RA R2 RD KEYPR RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCY. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Cot curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Output a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMSG. Message 5: "IDL". Restore stack. Point to next op code. Branch to output new line. Get op code. Get instruction bits.
0101 0107 0109 01006 0101 0111 01113 01114 01117 01118 01119 01110 01120 01212 01212 01212 01212 01212 01212 01213 01212 01212 01213 01212 01213	22 3F 05 07 99 77 00 03 99 77 00 04 22 05 5D A8 9D F6	MSG5	BNJ BLU BR LIDI MARK SEP DEC LIDI SHR SHR SEP DEC LIDI SHR SHR SEP DEC LIDI SHR SHR SEP DEC NOP LIDI SHR SEP DEC NOP LIDI SHR SHR SEP DEC NOP LIDI SHR SHR SHR SHR SEP DEC NOP LIDI SHR	KEYPR2 KEYR12 MAIN "OA" RA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD RE RD RD RE RD RD RE RD RD RE RD	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr how. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Cet curr addr low. Left nybble into right. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMGG. Message 5: "IDL". Restore stack. Point to next op code. Branch to output new line. Get op code. Branch to output new line. Get op code. Branch to output new line. Get op code.
01.01 01.07 01.09 01.00 01.01 01.13 01.14 01.18 01.18 01.18 01.19 01.10 01.20 01.21 01.23 01.24 01.25 01.25 01.25 01.25 01.31 01.33 01.34 01.38	22 3F 05 07 99 F8 0A 99 79 DA 22 06 F6	MSG5	BNL BL BR LDR LDR LDR LDR LDR LDR LDR LDR LDR LD	KEYPR2 KEYL2 MAIN "OA" FA R2 "O6" R8 "5D" R8 RD "OF" R8 RD "OF" R8 RD TESTON RB R2 RD TESTON RB R2 RD RE RC RD RE RC	Loop till key pressed. Loop till released. Branch, start over. Output Line Feed. Save X, P. Jmp subroutine OUTCH. Restore stack. R6 points to OUTDGT. Get curr addr hi. Left nybble into right nybble. Jmp subroutine OUTDGT. Get curr addr hi. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Jmp subroutine OUTDGT. Get curr addr low. Left nybble into right. Cot curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Get curr addr low. Mask off upper bits. Jmp subroutine OUTDGT. Cotput a space. Save P, X. Jmp subroutine OUTCH. Restore stack. Get op code. If not OO, branch. Else save X, P. Jmp subroutine OUTMSG. Message 5: "IDL". Restore stack. Point to next op code. Branch to output new line. Get op code. Get instruction bits.



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01170	DB .	MSG6	SEP	RB	Jmp subroutine OUTMSG. Message 6: "LDN".
OTITO OTITO	4C 111 1E	MSGO			•
0450	Cl ₄	OUTNBR	DEC	R2	Restore stack.
0451	C4		NOP		
0453	F8 52		LDI MARK	"52"	Output "R".
0455	79 DA		SEP	RA	Jmp subroutine OUTCH.
0457	22	OUTREG	DEC	R2	Restore stack.
0458 0459	OD FA OF		IDN ANI	RD "OF"	Get op code. Mask off upper bits.
0459 045B	D8		SEP	R8	Output reg nbr.
0450	30 3C		BR	NEXTOP	Branch to ING RD.
045E 045F	02 FF 01	TESTIN	LDN SMI	R2	Get op code. Op code = 1?
0461	3A 72 79		BNZ	TEST2N	No, branch.
0463 0464		2344	MARK	RB	Else, yes. Out msg 7.
0465	DB 45 43	MSG7	SEF	nd.	Message 7: "INC".
0468	20 20 00		DEG	n'à	-
046B	22 F8 52		DEC	R2	Restore stack. Output "R".
046E	79		MARK		
046F 0470	DA 30 57		SEP	RA OUTREG	Br to out reg nbr.
0472	02	TEST2N	IDN .	R2	Get op.
0473	FF 02		SMI	"02"	Op = 2N?
0475 0477	3A 81 79		BNZ	TEST4N	No, branch. Yes.
0478	DB		SEP	RB	Jmp SR OUTMSG.
0479	44 45 43	MSG8			Message 8: "DEC".
047C 047F	20 20 00 30 50		BRT	OUTNBR	Br to out reg nbr.
0481	02	TEST4N	LDN	R2	Op code = 4N?
0482 0484	FF 04 3A 90		SMI BNZ	"ОЦ" TEST5N	No, branch.
0486	79		MARK		Yes.
0487	DB	MSG8	SEP	RB	Out "LDA".
оц88 оц8в	4C 44 41 20 20 00	risdo			
048E	30 50	mnometer	BR	OUTNBR	Out reg nbr.
0490	02 FF 05	TEST5N	LDN	R2	Get op. Op = 5N?
0493	3A 9F		BNZ	TEST6N	No, branch.
0495	79 DB		MARK	RB	Yes, out "STR".
0496	53 54 52	MSG9	SEF	ND	
OL9A	20 20 00		DD	OHENDO	-
049D 049F	30 50 02		BR LDN	OUTNBR R2	Get op.
OLLAO	FF 06		SMI	"06"	Op code = 6N?
OLA2	3A C8		BNZ	TEST8N	No, branch.
	OD		TIDNI	DD.	
OLAL	OD FA OF		LDN	RD "OF"	Yes, "INP" or "OUT"?
OLAS OLAS	FA OF 52		ANI	"OF" R2	Yes, "INP" or "OUT"? Mask upper bits. Save.
OLAL OLAS OLA7 OLA8	FA OF 52 FF 08		ANI STR SMI	"OF" R2 "O8"	Yes, "INP" or "OUT"? Mask upper bits. Save. "INP"?
OLAS OLAS	FA OF 52 FF 08 33 B9 79		ANI STR SMI BPZ MARK	"OF" R2 "O8" NOTINP	Yes, "INP" or "OUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT".
OLAL OLAS OLAS OLAA OLAC OLAC	FA OF 52 FF 08 33 B9 79 DB	MSGIO	ANI STR SMI BPZ	"OF" R2 "O8"	Yes, "INP" or "OUT"? Mask upper bits. Save. "INP"? No, branch.
OLAL OLAS OLAS OLAB OLAA OLAC	FA OF 52 FF 08 33 B9 79	MSG10	ANI STR SMI BPZ MARK	"OF" R2 "O8" NOTINP	Yes, "INP" or "OUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT".
OLIALI OLIAS OLIAS OLIAS OLIAC OLIAD OLIAE OLIAE OLIBI OLIBI	FA OF 52 FF 08 33 B9 79 DB LF 55 5L 20 20 00 CL	MSG10	ANI STR SMI BPZ MARK SEP	"OF" R2 "O8" NOTINP	Yes, "INP" or "OUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT".
OLAL OLAS OLAS OLAS OLAC OLAC OLAD OLAE OLBI OLBI OLBI	FA OF 52 FF 08 33 B9 79 DB LF 55 54 20 20 00 C4 C4	MSG10	ANI STR SMI BPZ MARK SEP NOP	"OF" R2 "O8" NOTINP	Yes, "INP" or "OUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT".
OLAL OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52 FF 08 33 B9 79 DB LF 55 54 20 20 00 CL CL CL 30 C1		ANI STR SMI BPZ MARK SEP NOP NOP NOP BR	"OF" R2 "O8" NOTINP	Yes, "INP" or "OUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT".
OLAI OLAS OLAA OLAC OLAD OLAE OLBI OLBI OLBS OLBS OLBS OLBS OLBS OLBS	FA OF 52 FF 08 33 B9 79 DB 4F 55 54 20 20 00 CU CU CU 79	MSG10	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK	"OF" R2 "O8" NOTINP RB	Yes, "INP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR CUTMSG Br to out port nbr.
OLAL OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52 FF 08 33 B9 79 DB LF 55 54 20 20 00 CL CL CL 30 C1		ANI STR SMI BPZ MARK SEP NOP NOP NOP BR	"OF" R2 "O8" NOTINP	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG.
OLALI OLAS OLAS OLAS OLAC OLAD OLAE OLAE OLBI OLBI OLBS OLBS OLBS OLBS OLBB OLBB	FA OF 52	NOTINP MSG11	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP	"OF" R2 "OB" NOTINP RB OUTPRT	Yes, "INP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP".
OLALI OLAS OLAS OLAS OLAC OLAC OLAC OLAE OLBI OLBI OLBI OLBS OLBS OLBS OLBS OLBS OLBS OLBS OLBS	FA OF 52 FF 08 33 B9 79 DB	NOTINP	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP	"OF" R2 "OB" NOTINP RB OUTPRT RB	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack.
OLALI OLAS OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52	NOTINP MSG11	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP BR MARK SEP	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "O7"	Yes, "INP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits.
OLALI OLAS OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52 FF 08 33 B9 79 DB LF 55 5L 20 20 00 CL CL CL 30 C1 79 DB L9 LE 50 20 20 00 22 0D FA 07 DB	NOTINP MSG11	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LDN ANI SEP	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "07" R8	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT.
OLALI OLAS OLAS OLAA OLAD OLAE OLBI OLBI OLBS OLBS OLBS OLBS OLBS OLBS OLBS OLBS	FA OF 52	NOTINP MSG11	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP SEP MARK SEP DEC LIDN ANI SEP BR LIDN	"OF" R2 "OB" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2	Yes, "INP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Get op.
OLALI OLAS OLAS OLAS OLAS OLAS OLAD OLAD OLBI OLBI OLBI OLBS OLBS OLBS OLBS OLBS OLBS OLCS OLCS OLCS OLCS OLCS	FA OF 52 O8 33 B9 79 DB 4F 55 54 20 20 00 CL CL CL CL CL CD DB 4E 50 20 20 00 CD FA O7 DB 30 3C O2 FF 08	NOTINP MSG11 OUTPRT	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP MARK SEP DEC LDN SEP BR LDN SMI	"OF" R2 "OB" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2 "08"	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N?
OLALI OLAS OLAS OLAA OLAD OLAE OLBI OLBI OLBS OLBS OLBS OLBS OLBS OLBS OLBS OLBS	FA OF 52 O8 33 B9 79 DB 4F 55 54 20 20 00 CL CL CL CL CL CD DB 4E 50 20 20 00 CC CD CD FA O7 DB 6	NOTINP MSG11 OUTPRT	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP SEP MARK SEP DEC LIDN ANI SEP BR LIDN	"OF" R2 "OB" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch.
OLALI OLAS OLAS OLAS OLAS OLAD OLAD OLBI OLBI OLBI OLBI OLBS OLBS OLBS OLBS OLCS OLCS OLCS OLCS OLCS OLCS OLCS OLC	FA OF 52	NOTINP MSG11 OUTPRT TEST8N	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP NOP NOP NOP SEP BR LDN ANI SEP BR LDN SEP BR	"OF" R2 "OB" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2 "08"	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N?
OLALI OLAS OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52	NOTINP MSG11 OUTPRT	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN SMI SEP BR LIDN SMI BR LIDN SMI BR	"OF" R2 "OB" NOTINP RB OUTPRT RB R2 RD "07" R8 NEXTOP R2 "OB" TEST9N	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch.
OLALI OLAS OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52	NOTINP MSG11 OUTPRT TEST8N	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP NOP SEP DEC LDN ANI SEP BR LDN SMI BNZ MARK SEP	"OF" R2 "OB" NOTINP RB OUTPRT RB R2 RD "07" R8 NEXTOP R2 "OB" TEST9N	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch.
OLALI OLAS OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52 O8 33 B9 79 DB 4F 55 54 20 20 00 CL CL CL CL CL CD DB 4E 50 20 20 00 CC CD CD FA O7 DB 30 3C CD FF 08 3A E0 79 LC LF 20 20 00 C2 CL CL CL CD	NOTINP MSG11 OUTPRT TEST8N	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP BR MARK SEP DEC LDN ANI SEP BR LDN SMI BNZ MARK SEP	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "07" R8 NEXTOP R2 "O6" TEST9N RB	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GLO".
OLALI OLAS OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52	NOTINP MSG11 OUTPRT TEST8N	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP NOP SEP DEC LDN ANI SEP BR LDN SMI BNZ MARK SEP	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "07" R8 NEXTOP R2 "O6" TEST9N RB	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GLO".
OLALI OLAS OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52	NOTINP MSG11 OUTPRT TEST8N	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LDN ANI SEP BR LDN ENZ MARK SEP	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "07" R8 NEXTOP R2 "O6" TEST9N RB	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GLO".
OLALI OLAS OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52	NOTINP MSG11 OUTPRT TEST8N	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP LIDN ANI SEP LIDN SMI ENZ MARK SEP DEC NOP NOP NOP NOP LIDI MARK	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "07" R8 NEXTOP R2 "08" TEST9N RB R2	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GLO". Restore stack. Out "R".
OLAI OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 O8 33 B9 79 DB 4F 55 54 20 20 00 CL CL CL CD	NOTINP MSG11 OUTPRT TEST8N	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN ANI SEP LIDN ENZ MARK SEP DEC NOP NOP LIDI MARK SEP	"OF" R2 "'O8" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2 "O8" TEST9N RB R2 "152" RA	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GIO". Restore stack.
OLALI OLAS OLAS OLAS OLAS OLAS OLAS OLAS OLAS	FA OF 52	NOTINP MSG11 OUTPRT TEST8N MSG12	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN ANI SEP LIDN SMI BNZ MARK SEP DEC NOP	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "07" R8 REXTOP R2 "O8" TEST9N RB R2 "52" RA OUTREG	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GIO". Restore stack. Out "R". Jmp SR OUTCH.
OLAI OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 O8 33 B9 79 DB 4F 55 54 20 20 00 CL CL CL CD	NOTINP MSG11 OUTPRT TEST8N	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN ANI SEP LIDN ENZ MARK SEP DEC NOP NOP LIDI MARK SEP	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2 "O8" TEST9N RB R2 "52" RA OUTREG R2 "09"	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTCT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GIO" Restore stack. Out "R" Get op. Op = 9N?
OLAI OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 OS STATE OF	NOTINP MSG11 OUTPRT TEST8N MSG12	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN ANI SEP LIDN SMI ENZ MARK SEP DEC NOP	"OF" R2 "OB" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2 "O8" TEST9N RB R2 "O8" TEST9N RB	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GIO" Restore stack. Out "R" Jmp SR OUTCH Get op. Op = 9N? No, branch.
OLAI OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 OS STATE OF	NOTINP MSG11 OUTPRT TEST8N MSG12	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN SMI SEP BR HARK SEP DEC LIDN SMI SEP BR HARK SEP HOP NOP NOP NOP NOP NOP NOP NOP NOP NOP N	"OF" R2 "OB" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2 "OB" TEST9N RB R2 "OB" TEST9N RB R2 "OB" TEST9N RB	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTCT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GIO" Restore stack. Out "R" Get op. Op = 9N?
OLAI OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 OS STATE OF	NOTINP MSG11 OUTPRT TEST8N MSG12	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN ANI SEP LIDN SMI ENZ MARK SEP DEC NOP	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2 "O8" TEST9N RB R2 "52" RA OUTREG R2 "09"	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GIO" Restore stack. Out "R" Jmp SR OUTCH Get op. Op = 9N? No, branch. Yes, out "GIO".
OLALI OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 OS S14	NOTINP MSG11 OUTPRT TEST8N MSG12	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN SMI SEP BR LIDN SMI SEP BR LIDN SMI SEP BR LIDN SMI SEP BR LIDN SMI SEP NOP NOP NOP NOP NOP NOP NOP NOP NOP NO	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "07" R8 NEXTOP R2 "06" TEST9N RB R2 "UBB R2 "UBB R2 "UBB R2 "UBB R2 "UBB R2 "UBB R3 R4 R5 R5 R5 R6 R7 R8 R8 R8 R8	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP" Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GIO" Restore stack. Out "R" Jmp SR OUTCH Get op. Op = 9N? No, branch. Yes, out "GIO".
OLAI OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 OS 514 OS 55 S14 OS 55 S14 OS C1	NOTINP MSG11 OUTPRT TEST8N MSG12	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN SMI SEP BR HARK SEP DEC LIDN SMI SEP BR HARK SEP HOP NOP NOP NOP NOP NOP NOP NOP NOP NOP N	"OF" R2 "OB" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2 "OB" TEST9N RB R2 "OB" TEST9N RB R2 "OB" TEST9N RB	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GLO". Restore stack. Out "R". Jmp SR OUTCH. Get op. Op = 9N? No, branch. Yes, out "GHI".
OLAIS OLAA OLAA OLAA OLAA OLAA OLAA OLAA OLA	FA OF 52 O8 33 B9 79 DB LF 55 54 20 20 OC CLL CLL CL	NOTINP MSG11 OUTPRT TEST8N MSG12 TEST9N MSG13	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP BR MARK SEP LIDN SMI BNZ MARK SEP NOP NOP NOP NOP NOP NOP NOP NOP NOP NO	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "07" R8 NEXTOP R2 "06" TEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UTREG R3 "UTREG R4 "UTREG R4 "UTREG R5 "UTREG R6 "UTREG R7 "UTREG R8	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GIO". Get op. Get op. Op = 9N? No, branch. Yes, out "GHI". Get op. Op = 9N? No, branch. Yes, out "GHI". Get op. Op = AN?
OLAI OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 O8 33 B9 79 DB 4F 55 54 20 20 00 CL CL CL CL CD	NOTINP MSG11 OUTPRT TEST8N MSG12 TEST9N MSG13	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN ANI SEP BR LIDN ANI BNZ MARK SEP DEC NOP NOP LIDI MARK SEP BR LIDN SMI BNZ BR LIDN SMI BNZ BR LIDN SMI BNZ	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "O7" R8 TEST9N RB R2 "O8" TEST9N RB R2 "OUTREG R2 "IO9" TESTAN RB	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP".
OLAIS OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 OS SIA SIA SIA SIA SIA SIA SIA SIA SIA SI	NOTINP MSG11 OUTPRT TEST8N MSG12 TEST9N MSG13 TESTAN	ANI STR SMI BPZ MARK SEP NOP NOP NOP NOP BR MARK SEP LIDN SMI BNZ MARK SEP NOP NOP NOP NOP NOP NOP NOP NOP NOP NO	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "07" R8 NEXTOP R2 "06" TEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UFEST9N RB R2 "UTREG R3 "UTREG R4 "UTREG R4 "UTREG R5 "UTREG R6 "UTREG R7 "UTREG R8	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP". Restore stack. Get op. Mask upper bits. Jmp SR OUTDGT. Get next op. Get op. Op = 8N? No, branch. Yes, out "GIO". Get op. Get op. Op = 9N? No, branch. Yes, out "GHI". Get op. Op = 9N? No, branch. Yes, out "GHI". Get op. Op = AN?
OLAI OLAF OLAF OLAF OLAF OLAF OLAF OLAF OLAF	FA OF 52 OS S S S S S S S S S S S S S S S S S S	NOTINP MSG11 OUTPRT TEST8N MSG12 TEST9N MSG13	ANI STR SMI BPZ MARK SEP NOP NOP NOP BR MARK SEP DEC LIDN ANI SEP LIDN SMI ENZ MARK SEP DEC NOP NOP NOP NOP NOP NOP NOP NOP SMI ENZ MARK SEP BR LIDN SMI ENZ MARK SEP BR LIDN SMI ENZ MARK	"OF" R2 "O8" NOTINP RB OUTPRT RB R2 RD "O7" R8 NEXTOP R2 "O8" TEST9N RB R2 "U7" RA OUTREG R2 "109" TESTAN RB OUTNER RC "109" TESTAN RB OUTNER R2 "O4" TESTEN	Yes, "IMP" or "CUT"? Mask upper bits. Save. "INP"? No, branch. Else, "CUT". Jmp SR OUTMSG. Br to out port nbr. Jmp SR OUTMSG. Out "INP".

04F9	20 20 00				- 1
OLFC	30 50		BR	OUTNBR	-
04FE	02		LDN	R2 .	Get op.
OLFF	FF OB		SMI	"OB"	Op = BN?
0501	3A OE		BNZ	TESTON	No, branch.
0503	79		MARK		Yes, out "PHI".
0504	DB		SEP	RB	-
0505	50 48 49	MSG15			
0508	20 20 00			OTIMILIDE	·
050B	CO 04 50		LBR	OUTNBR	-
050E	02	TESTON	LDN	R2	Get op.
050F	FF OD		SMI	"OD"	Op = DN?
0511	3A 25		BNZ	TESTEN	No, branch.
0513	79 .		MARK	p	Yes, out "SEP".
0514	DB		SEP	RB	Jmp SR OUTMSG.
0515	53 45 50	MSG16	477	4	
0518	20 20 00	- Contract			-
051B	22	OUTEQL	DEC	R2	
051C	79		MARK	DE	Output "=R".
051D	DB		SEP	RB	
051E	3D 52 00	MSG17			
0521	Ch		NOP	OTTO TO	0.1
0522	CO 04 57	mnamny	LBR	OUTREG	Out reg nbr.
0525	02	TESTEN	LDN	R2	Get op.
0526	FF OE		SMI	"OE"	Op = EN?
0528	3A 34		BNZ	TEST3N	No, branch.
052A	79		MARK	DD.	Yes, out "SEX".
052B	DB	W0070	SEP	RB	
052C	53 45 58	MSG18			-
052F	20 20 00				
0532	30 1B		BR	OUTEQL	Br to output "=R".
0534	C4	TEST3N	NOP		
0535	C4		NOP		4
0536	Cħ .		NOP	100	
0537	02		IDN	R2	Get op.
0538	FF 03		SMI	"03"	Op = 3N?
053A	3A 82		BNZ	TEST7N	No, branch.
053C	OD		LDN	RD	Get op code.
053D	FF 38		SMI	"38"	Op = "SKP"?
053F	3A 4D		BNZ	OUTBR	No, branch.
0541	79		MARK		Yes, out "SKP".
0542	DB	Teller I	SEP	RB	-
0543	53 4B 50	MSG19			
0546	00 .				
0547	C4		NOP		-
0548	C4		NOP		
0549	22		DEC	R2	-
05LA	co o4 3c	LBRNXT	LBR	NEXTOP	Br to get more code.
054D	F8 42	OUTBR	IDI	"42"	Out "B".
054F	79		MARK		
0550	DA		SEP	RA	·
0551	22		DEC		
0552	F8 07		LDI	"07"	R7 points to 3N table.
0554	B7		PHI	R7	
0555	OD		LDN	RD	Get op.
0556	FA OF		ANI	"OF"	Mask off upper bits
0558	A7		PLO	R7	to point to mnemonic.
0559	07		LDN	R7	Get character.
055A	79		MARK	1.3	Out character.
055B	DA		SEP	RA	The state of the s
055C	22		DEC	R2	-
055D	87		GLO	R7	R7 point to next char.
055E	FC 10		ADI	11011	-
0560	A7		PLO	R7	Cost word observ
0561	07		LDN	R7	Get next char.
0562	79		MARK	D4	Out next char.
0563	DA		SEP	RA	
0564	22		DEC MARK	R2	Out 2 ansess
0565	79			RB	Out 2 spaces.
0566	DB	месоо	SEP	RB	
0567	20 20 00	MSG20	DEC	R2	•
056A 056B	9D		GHI	RD	Get curr addr.
056C	F6		SHR	TW.	Out hi order digit.
056D	F6		SHR		- order arking
056E	F6		SHR		
056F	F6		SHR		
0570	D8		SEP	D8	Jmp SR OUTDGT.
0571	9D		GHI	RD	Out 2nd addr digit.
0572	FA OF		ANI	"OF"	-
0574	D8		SEP	R8	Jmp SR OUTDGT.
0575	10	OUTADD	INC	RD	Out branch addr.
0576	OD ,		LDN	RD.	Out br addr hi digit.
0577	F6		SHR		-
0578	F6		SHR		-
0579	F6		SHR		-
057A	F6		SHR		-
057B	D8		SEP	R8	o = 10 - Start lines
057C			LDN	RD	Out br addr low digit.
057D	OD		ANI	"OF"	-
057F			NI.T	DO.	
	OD FA OF D8		SEP	R8	-
0580	OD FA OF D8 30 LA		SEP BR	LBRNXT	Br to get more code.
	OD FA OF D8 30 LA O2	TEST7N	SEP BR LDN	LBRNXT R2	Get op.
0580	OD FA OF D8 30 LA	TEST7N	SEP BR LDN SMI	LBRNXT R2 "07"	Get op. Op = 7N?
0580 0582 0583 0585	OD FA OF D8 30 LA O2 FF O7 3A BO	TEST7N	SEP BR LDN SMI BNZ	LBRNXT R2 "07" TESTCN	Get op. Op = 7N? No, branch.
0580 0582 0583 0585 0587	OD FA OF D8 30 LA O2 FF O7 3A BO F8 O7	TEST7N	SEP BR LDN SMI BNZ LDI	LBRNXT R2 "07" TESTCN "07"	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic.
0580 0582 0583 0585 0587 0589	OD FA OF D8 30 LA O2 FF O7 3A BO F8 O7 B7	TEST7N	SEP BR LDN SMI BNZ LDI PHI	LBRNXT R2 "07" TESTCN "07" R7	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic. R7 points to 7N table.
0580 0582 0583 0585 0587	OD FA OF D8 30 LA O2 FF O7 3A BO F8 O7	TEST7N	SEP BR LDN SMI BNZ LDI	LBRNXT R2 "07" TESTCN "07"	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic.
0580 0582 0583 0585 0587 0589 058A	OD FA OF D8 30 LA O2 FF O7 3A BO F8 O7 B7 OD	TEST7N	SEP BR IDN SMI BNZ LDI PHI LDN	LBRNXT R2 "07" TESTCN "07" R7	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic. R7 points to 7N table. Get op.
0580 0582 0583 0585 0587 0589	OD FA OF D8 30 LA O2 FF O7 3A BO F8 O7 B7	TEST7N	SEP BR LDN SMI BNZ LDI PHI	LBRNXT R2 "07" TESTCN "07" R7 RD	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic. R7 points to 7N table.
0580 0582 0583 0585 0587 0589 058A	OD FA OF D8 30 LA 02 FF 07 3A B0 F8 07 B7 OD FA OF	TEST7N	SEP BR LDN SMI BNZ LDI PHI LDN	LBRNXT R2 "07" TESTCN "07" R7 RD "0F" "20" R7	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic. R7 points to 7N table. Get op. Mask upper bits.
0580 0582 0583 0585 0587 0589 058A 058B	OD FA OF D8 30 LA O2 FF O7 3A BO F6 O7 B7 OD FA OF FC 20 A7 F6 O4	TEST7N	SEP BR LDN SMI BNZ LDI PHI LDN ANI ADI	LBRNXT R2 "07" TESTCN "07" R7 RD "0F" "20" R7 "0h"	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic. R7 points to 7N table. Get op. Mask upper bits.
0580 0582 0583 0585 0587 0589 058A 058B 058B 058F 0590	OD FA OF D8 30 LA O2 FF O7 3A BO F8 O7 B7 OD FA OF FC 20 A7 F8 OL A6		SEP BR LDN SMI BNZ LDI PHI LDN ANI ADI PLO LDI PIO	LBRNXT R2 "07" TESTCN "07" R7 RD "0F" "20" R7 "0 " R6	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic. R7 points to 7N table. Get op. Mask upper bits. Adjust R7 low
0580 0582 0583 0585 0587 0588 0588 058B 058F 0590 0592 0593	OD FA OF FC 20 A7 F8 60 U	TEST7N OUT7N	SEP BR IDN SMI BNZ LDI PHI LDN ANI ADI PLO LDI PLO LDI PLO LDI	LBRNXT R2 "07" TESTCN "07" R7 RD "0F" "20" R7 "0h"	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic. R7 points to 7N table. Get op. Mask upper bits. Adjust R7 low R6 = char counter Get char.
0580 0582 0583 0585 0587 0589 058A 058B 058B 058F 0590	OD FA OF D8 30 LA O2 FF O7 3A BO F8 O7 B7 OD FA OF FC 20 A7 F8 OL A6		SEP BR LDN SMI BNZ LDI PHI LDN ANI ADI PLO LDI PIO	LBRNXT R2 "07" TESTCN "07" R7 RD "0F" "20" R7 "0 " R6	Get op. Op = 7N? No, branch. Yes, out 7N mnemonic. R7 points to 7N table. Get op. Mask upper bits. Adjust R7 low

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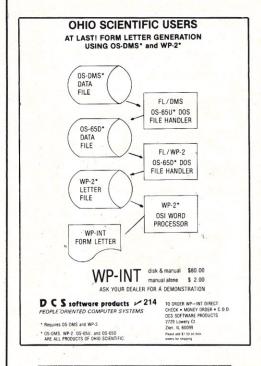
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0595	DA		SEP	RA	
0596	22		DEC	R2	-
0597	87		GLO	R7	R7 points to next
0598	FC 10		ADI	"10"	character.
059A 059B	A7 26		PLO	R7 R6	Char cntr minus 1.
059C	86		GLO	R6	Test cntr. Done?
059D	3A 93		BNZ	OUT 7N	No, branch.
059F	F8 20		IDI	"20"	Yes, out a space.
05A1	79		MARK	DA	-
05A2 05A3	DA 22		SEP	RA R2	
05A4	OD		LDN	RD	Get op.
05A5	FF 7E		SMI	"7E"	Op = "RSHL"?
05A7	32 LA		BZ	LBRNXT	Yes, branch. No, test.
05A9 05AA	OD FF 7C		LDN	RD	Op less than "ADCI"?
OSAC	3B 14A		BM	LBRNXT	Yes, branch.
OSAE .	30 75		BR	OUTADD	No, br to out addr.
05B0	02	TESTON	LDN	R2	Get op.
05B1	FF OC		SMI	"OC"	Op = CN?
05B3	CA 06 18 C4		LBNZ NOP	TESTFN	No, branch. Else yes, out mnemonic.
05B6 05B7	Ch		NOP		-
05B8	OD		LDN	RD	Get op.
05B9	FF C4		SMI	"Ch"	Op = "NOP"?
05BB	3A C6		BNZ	OUTCN	No, branch.
05BD	79		MARK	RB	Yes, out "NOP".
O5BE O5BF	DB 4E 4F 50	MSG21	SEF	RB	_
0502	00	1.DGL I			-
0503	22		DEC	R2	-
0504	30 LA		BR	LBRNXT	Br to get next op.
0506	F8 4C	OUTCN	LDI	"4C"	Out "L".
05C8 05C9	79 DA		MARK	RA	
05CA	22		DEC	R2	-
05CB	F8 07		LDI .	"07"	R7 points to CN table.
O5CD	B7		PHI	R7	-
OSCE	OD EA OF		LDN ANI	RD "OF"	. .
05CF 05D1	FA OF FC 60		ADI	"60"	
05D3	A7		PLO	R7	-
05D4	F8 03		LDI	"03"	R6 = character cntr.
05D6	A6	OIMOOD	PLO	R6	- 0-t
05D7	07	OUTCOP	LDN MARK	R7	Get character. Out char.
05D8 05D9	79 DA		SEP	RA	-
O5DA	22		DEC	R2	•
OSDB	87		GLO	R7	R7 point to next char.
OSDC	FC 10		ADI	"10"	•
OSDE OSDE	A7 26		PLO	R7 R6	Char cntr - 1.
05DF 05E0	86		GLO	R6	All chars out?
05E1	3A D7		BNZ	OUTCOP	No, branch.
05E3	F8 20		LDI	"50"	Cut a space.
05E5	79		MARK	D.	·
05E6	DA 22		SEP	RA R2	:
05E7 05E8	C4		NOP	112	
05E9	OD		LDN	RD	Get op.
O5EA	FF C5		SMI	"C5"	Op = "LSNQ"?
OSEC	32 lA		BZ	LBRNXT	Yes, branch.
OSEF OSEF	OD FF C6		IDN SMI	RD "C6"	Get op. Op = "LSNZ"?
05F1	32 LA		BZ	LBRNXT	Yes, branch.
05F3	OD		LDN	RD	Get op.
05FL	FF C7		SMI	"C7"	Op = "LSNF"?
05F6 05F8	32 LA OD		BZ LDN	LBRNXT RD	Yes, branch. Get op.
05F9	FF C8		SMI	"C8"	Op = "LSKP"?
05FB	32 4A		BZ	LBRNXT	Yes, branch.
05FD	OD		LDN	RD	Get op.
05FE 0600	FF CC C3 O5 4A		SMI LBPZ	"CC" LBRNXT	Op less than "LSIE"? No, branch. Done.
0603	F8 02		LDI	"O2"	Yes, R6 = byte cntr.
0605	A6		PLO	R6	-
0606	1 D	OUTAD2	INC	RD	Get long branch addr hi.
0607	OD E4		LDN	RD	Out hi onder die't
0608	F6 F6		SHR		Out hi order digit.
060A	F6		SHR		-
060B	F6		SHR		-
060C	D8		SEP	R8	7.10
060D	OD EA OF		LDN	RD "OF"	Out low order digit.
060E 0610	FA OF D8		ANI SEP	R8	-
0611	26		DEC	R6	Byte cntr - 1.
0612	86		GLO	R6	Done?
0613	3A 06		BNZ	OUTAD2	No, branch.
0615	CO 05 4A	THE COURT	LBR LDI	LBRNXT	Yes, br to get more code.
0618 061A	F8 07 B7	TESTFN	PHI	R7	R7 points to FN table.
061B	OD		LDN	RD	Get op.
061C	FA OF		ANI	"OF"	Adjust pointer byte low.
061E	FC 90		ADI	"90"	-
0620	A7		PLO	R7	P6 - abancetont
0621	F8 03 A6		LDI	"03" R6	R6 = character counter.
0624	07	OUTFOP	LDN	R7	Get char.
			MARK		Out FN mnemonic.
0625			I THILLIA		
0626	79 DA		SEP	RA	-
0626 0627	79 DA 22		SEP DEC	R2	:
0626	79 DA		SEP		-

062B	A7		PLO	R7	_
0620	26		DEC	R6	Char cntr - 1.
062D	86		GIO	R6	Test cntr. Done?
062E	3A 24		BNZ	OUTFOP	No. branch back.
0630	79		MARK		Yes, done. Out 2 spaces.
0631			SEP	RB	
0632	20 20 00	MSG22	OBI	ILD	
0635	20 20 00	PIOUZZ	DEC	R2	
	OD		LDN	RD	Get op.
0636	FF F8		SMI	"F8"	Op less than "LDI"?
0637			LBM	NEXTOP	Yes, branch.
0639	CB 04 3C				
0630	OD		LDN	RD	No, get op.
063D	FF FE		SMI	"FE"	Op = "SHL"?
063F	C2 OH 3C		LBZ	NEXTOP	Yes, branch.
0642	co o5 75		LBR	OUTADD	No, branch to out operand.
				SUBROUTI	NES
0645	D3	RTNL	SEP	R3	Return to caller.
0646	6C	GETHEX	INPL	-	Input hex byte.
0647	52		STR	R2	Save.
0648	64		OUTL		Output hex byte to display.
0649	22		DEC	R2	Restore stack.
O6LA	3F 46		BNL	GETHEX	Loop till INPUT key pressed.
06LC	37 LC	KEYRL2	BL	KEYRL2	Loop till INPUT released.
064E	30 45		BR	RTN4	Br to return.
0650	E2	RTN5	SEX	R2	Restore stack pointer.
0651	12		INC	R2	Restore stack.
0652	70		RET	102	Return to caller.
0653	FO	OUTMSG			Get character via old R(P).
0654	32 50	OUTFISG	BZ	RTN5	If "00", end. Branch.
0656	72		LDXA	KIN)	Else, get char and INC R(X).
0657	79		MARK		Out character.
0658			SEP	RA	Jmp SR OUTCH.
	DA			R2	
0659	22		DEC	OUTMSG	Restore stack. Br to get another char.
065A	30 53		BR	UUIMSG	Br to get another char.
065C	D3	RTN6	SEP	R3	Return to caller.
065D	FF OA	OUTDGT	SMI	"OA"	Digit less than OA hex?
065F	C7		LSM	12000200	Yes, skip next instr.
0660	FC 07		ADI	"07"	No, hex to decimal.
0662	FC 3A		ADI	"3A"	Decimal digit to ASCII.
0664	79		MARK		Out character.
0665	DA		SEP	RA	-
0666	22		DEC	R2	-
0667	30 5C		BR	RTN6	Br to return.
0668 -	- 0700	STACK			

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A/D Converter Design For the TRS-80 Level II

Read voltages from 0 to +10 volts, and display the results on the video monitor.

Arthur Mullin, Jr. Rte. 3, Box C-9 Beaumont, TX 77706

This circuit and accompanying software will allow the user to read voltage from 0 to +10 volts and display the results on the video monitor. I am using a 9 volt battery to test the system, but any source of voltage will do as long as the maximum ratings are not exceeded. This opens up a whole world of possibilities, such as tempera-

ture monitors or wind-speed monitors. Fig. 1 shows that this circuit

Fig. 1 shows that this circuit is simple to build since there are only three chips. The heart of the circuit is the analog-to-digital converter AD 570, which can be purchased from Analog Devices (Rte. 1, Industrial Park, PO Box 280, Norwood, MA 02062) for about \$23. A quad NAND gate, the 74LS00, and the octal Tri-state non-inverting buffer, 81LS95, can be purchased from a local parts store at nominal prices.

The AD 570

The AD 570 converts a voltage in the range of 0 to \pm 10 volts into a corresponding binary number and presents this number to the computer. If the input voltage is 0, then the number output is 0. If the input voltage is \pm 10, then the binary number output is 255. Accordingly, if the voltage is \pm 5, then the output is 127.

By instructing the computer to divide the binary number it receives by 255, a percentage of full-scale voltage will be obtained. For instance, if the input voltage is +5 volts, the number the computer receives will be 127. If 127 is divided by 255, the result will be .49803922 (let's call it .5). By multiplying this value by 10, we can read voltage directly on the video monitor. Notice that if we advance the voltage to the converter ever so slightly so as to make the output binary

number equal to 128, the result of dividing by 255 will yield an answer of .50196078.

From this, you can see that there are "gaps" in the conversion from analog to digital. This is an inherent characteristic of digitization, and further understanding of this phenomenon can be achieved by reading up on analog-to-digital conversion.

Conversion Cycle

Refer to Fig. 2. The normal state of affairs is, of course, for OUT* to be high (close to 5 volts). NAND gate A will have a low (close to 0 volts) on pin 3. Since pin 3 is connected to pin 4 of gate B, pin 6 is forced high, and pin 2 of gate A is high, further convincing pin 3 of gate A to be low.

At this time, DATA READY* is low, and data is available at pins 2-9 of the A/D converter. If we did not use a Tri-state buffer network to accept this data, the computer would be flaking out about now. Since DATA READY* is low, pin 8 of gate C is high. This further reinforces a high at pin 6 of gate B, since pin 4 is already low.

Since DATA READY* is low and data is available at pins 2–9, there is nothing preventing us from reading data into the computer at this time. All we have to do is force pins 1 and 19 of the 81LS95 to go low. This can be done by typing "PRINT INP(1)" (or any address). The

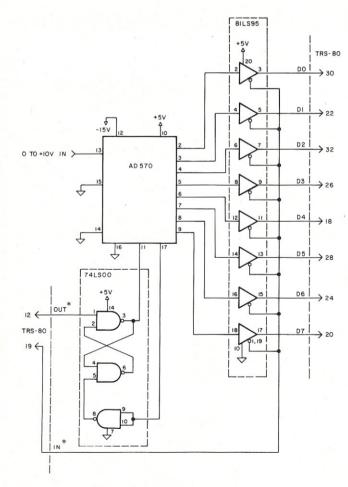


Fig. 1. Assembly schematic.

computer will print whatever is available at pins 2-9 of the converter.

But let's not read the data at the buffers yet. Instead, let's get a new value from the converter and then read the data. To do this, it will be necessary to bring the CONVERT* pin of the AD data from the converter at this time, since data is available at pins 2–9 of the converter only when DATA READY* is low. Fortunately, from the standpoint of chip count, we do not have to hold the computer up, and DATA READY* goes low when the converter has completed its task.

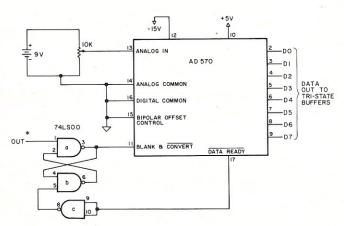


Fig. 2. A/D converter.

570 from its low state to a high state and then back to a low state. I find it more understandable to view this process as giving the converter a "kick."

Let's type "OUT 0,0". Again, any address and any number output (0 to 255) will do, since we're only interested in forcing the OUT* line to go low. When OUT* goes low, pin 3 of NAND gate A goes high, making pin 11 of the converter go high. After about 1.5 microseconds, DATA READY* goes high and no data is available at pins 2–9 of the converter.

When DATA READY* goes high, pin 8 of NAND gate C goes low, forcing pin 6 of gate B to go high. Now pin 2 of gate A is high and OUT* has gone back to its normal high state. This forces pin 3 of gate A back low, taking pin 11 of the converter with it.

Now the converter is going through its conversion cycle, which takes about 25 microseconds. While the converter is busy converting the analog voltage at pin 13 of the converter, DATA READY* is still high and will not go low until the conversion is complete.

If the TRS-80 were an extremely fast machine, we would have to delay any requests for Now we are in the state initially described, and the new data is available at pins 2-9. We can ask for this data by requesting an input and enabling the Tristate buffers.

The AD 570 can process +5 and -5 volts by lifting pin 15 from ground. In this mode, -5 volts gives an output of 0, +5 volts gives a binary 255, and 0 volts gives 127 output.

Listing 1 will print the binary output of the converter at the top left side of the video monitor, while displaying the voltage value in the center of the screen

For those of you wishing more detailed information on conversion techniques in general, or the AD 570 specifically, I suggest you read "Analog-Digital Conversion Notes" or the data sheet on the AD 570. Both can be obtained from Analog Devices.

10 CLS 20 OUT 1

20 OUT 1, 1 30 PRINT @0, INP(1)

40 A = (INP(1)/255) + 10

50 PRINT @540, A 60 GOTO 20

60 GOT

Listing 1.



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MICRO-SCOPE

Hardware and Underwear

A New Haven, Connecticut, manufacturer of electronic instruments and hardware has recently changed its name to Global Specialties Corporation. The name change reflects the changing nature of the company, as company President Ronald J. Portugal explains: "Today, our sales network is truly global in nature. We have expanded our horizons, and in doing so have worked to expand the horizons of the industry. In everything we have set out to do, our goal has been to think broadly, to appeal to the many instead of the few, to offer customers new kinds of tools to make their work easier, less aggravating, less time-consuming. And we have worked to increase the world's understanding of these tools, to show them new ways to use them, to teach them easier ways to get their work done."

Such lofty goals are admirable, but it was such broadmindedness that raised more than a few eyebrows at the company's headquarters in Great Britain. The company's original name was Continental Specialties, which had a more suggestive meaning in England and parts of Europe. It alluded to such esoteric novelties as peek-a-boo lingerie, "French Ticklers" and marital aids.

The "naughty-naughty" implications in the European markets became a growing embarrassment. This may, perhaps, have been compounded by the fact that the company's European operations were conducted by an office staffed almost entirely by women, and headed by a very proper English lady, Mrs. Tina Knight, managing director.

With the name change, Global Specialties continues its overseas operations, but without prompting an embarrassed blush.

Is There a Doctor in the Studio?

One way in which the health care industry is seeking to keep costs down is through the use of videotape as a communications tool to train both patients and staff.

At Tucson General Hospital in Arizona, video equipment helps educate patients, who are as likely to see a program on "Living with Respiratory Illness" as the afternoon movie when they switch on the bedside television. Through video equipment, Tucson General makes medical programs available all day to interested patients. A patient can watch a tape of an operation he will undergo or choose a music program for relaxation before entering surgery.

At the University of Pittsburgh's Western Psychiatric Institute and Clinic (WPIC), educational programs are produced to inform patients about the medicines they are given, test and treatment procedures and available hospital facilities. According to one clinic spokesman, "By taping this information we hope to produce a patient education program that is comprehensive and consistent. Each patient will get the same complete explanation."

In many hospitals, groups of medical students crowd around a video cassette player and monitor, just as they once gathered to peer down into operating rooms from glass-walled balconies. One nursing home director finds video equipment invaluable for training personnel and staff education. Taping lectures eliminates the need to have the education director repeat them constantly and allows reaching evening and night shifts with vital information and lectures that are done live only during the day.

Several hospitals maintain their own audiovisual departments, which are involved in corporate communications, staff education and videotaping operations, diagnostic interviews, etc.

Since nonprofit institutions such as hospitals operate on limited budgets, they have to use their funds as efficiently as possible. More and more hospitals are producing their own films with videotape as a low-cost medical training tool.

Computer Beats Rush-Hour Blues

William Kelly needed a change of pace. He was bored with his daily commute to work and felt that his time could be more productively spent. Kelly, founder and president of SAI Electronics of Farmingdale, Long Island, wished the ability to process data during his commutation time, so he had a complete data-processing center installed in his car

The unit, installed by Berliner Computer Center of New Hyde Park, NY, includes a 48K RAM Apple computer with 232K of disk storage and three languages resident in ROM. It also features 16-color capability and complete sound synthesis. In addition to the computer unit, the company also installed a stereo system, radar detection units, burglar alarm systems, CB radio with automatic electric antenna, remote control starting system, videotape recorder and player, color video camera and 120 volt ac inverter to allow the use of small appliances, such as electric toothbrush, shaver, etc.

This equipment nicely complements the car's original accessories—sink with running water, soda dispenser, icebox, color TV and bar—which came equipped on Kelly's custom-built 1980 Cadillac Limousine.

Popcorn and Teleporn

Home information systems users may be getting more than they bargained for from the programming services, which normally provide homeowners with information, games and entertainment via specially adapted TV sets or home computers, but may now be spicing up their offerings with electronically transmitted pornographic material. This possibility has prompted speculation that censor-ship—either voluntary or government imposed—may soon emerge as an issue.

According to *Electronic Mail and Message Systems* (EMMS), recently, viewers of the British Prestel viewdata service were presented with the unexpected possibility of accessing a "dirty books guide." The publicity that surrounded this incident apparently embarrassed Sir William Barlow, chairman of the British Post Office, which imple-

mented this system for home computer usage in 1976 (see Microcomputing, October 1979, p. 94). He defended a hands-off policy on viewdata information, claiming that it was analogous to the (private) contents of telephone conversations or mail.

In the United States, other forms of new electronic gadgetry for the home are apparently benefiting, in part, from electronic porn. With about one million videotape recorders now installed in U.S. homes, the market for pornographic videotapes is "very strong," according to the EMMS article, which points to widespread advertising of taped porn in such "skin" magazines as Playboy, Penthouse and Forum.

Cable TV is another rapidly developing conduit for racy material. Subscribers to many CATV services who pay a nominal fee are offered a wide variety of entertainment "specials," including a selection of newly released films that typically include more than one uncut R-rated movie. While most Americans believe that pornography is OK as long as it is in the confines of the home and is out of sight, some executives in the consumer electronics and electronic message/home information industry worry that some of these services will become associated in the public mind with the world of pornography.

MicroNet, a consumer timesharing service, has gone to some lengths to protect their service from porno problems. The CB Simulator channels on MicroNet, which can be used for home computerists to talk to each other, are patrolled regularly by MicroNet staff members. Furthermore, the games available on MicroNet have a "Porno-Trap," which detects the use of obscenities by the game player. Once the computer detects bawdy language, it immediately cautions the player against using such words, and the player is likely to be further reprimanded when he finds a message addressed to him on the electronic "bulletin board" mentioning the incident.

Leaders in the electronic communications field believe that similar types of precautions will be developed and will prevent the electronic message field from becoming swamped in porno.

Today's Army Is Quicker, Lighter, More Efficient & Less Expensive

Computerized micropublishing is now a way of life in the U.S. Army. The Army has converted many of its publications into microfiche, which has significantly cut down on the costs and time required to publish Army indexes. The computer-output micrographics (COM) system has reduced the time necessary to about 30 days—from initial selection of data to mailing—in contrast to the former manual system, which could take as long as 9 months.

Because the Army's indexes now can be updated quickly and accurately, the most immediate effect will be felt worldwide by the more than 50,000 users who rely on the timeliness of the information contained in these publications—indexes to the Army's technical publications, administrative procedures, training and doctrinal publications, obsolete publications and an index of blank forms.

In addition to the cost savings and time factors, the microfiche system reduces the warehousing space required because the process uses no paper and eliminates the need for bulk handling and storage. An index of 1000 pages, for example, weighing several pounds in paper, weighs less than one ounce in microfiche form. Consequently, mailing rates, too, are drastically reduced. And, because of the swiftness, accuracy and efficiency of the microfiche method, the five indexes can now be published on a quarterly schedule.

With the new system, it is estimated that savings to the Army will be more than \$5 million over the previous system of publishing hard copy.

Watch for Tiny Bulges

Employees at IC manufacturing companies in Silicon Valley, California, may leave work with a chip on their shoulders, but if they leave with chips in their pockets, socks or shirt sleeves, they may get caught. According to Newsweek magazine (May 12, 1980), most IC companies are tightening security measures in an attempt to stem the incidence of chip loss due to employee stealing. One IC, the article states, can sell on the black market for as much as

Such a black market exists and is thriving because chip manufacturers are unable to keep up with the demand for these silicon wafers. Newsweek states that industry officials hope to balance supply and demand by increasing production capabilities.

Computer-Aided Aim

Hunters and fishermen are now better prepared to take to the wild to bag their favorite trophy after viewing the "Fish and Game Forecaster," a TV news insert that predicts when hunting and fishing conditions will be at their peak. The forecast is based on a computerized system that monitors and predicts optimum times for fish and game movements.

DataSport, Inc., a Hopkins, Minnesota-based computer research firm, and Vexilar, Inc., a Minneapolis marine electronics operation, develop the forecast for the show, which is marketed on TV stations throughout the U.S.

User-Oriented Information

Now potential buyers of data-processing products can receive specific information about registered products by directly contacting current users of the hardware or software. The Association of Computer Users (ACU) has originated a new reference service that benefits both users and suppliers.

When a DP supplier registers one or more of its products with ACU, it provides at least ten references per product from current users who have agreed to answer questions from potential buyers. The potential buyer requiring specific information simply contacts ACU, which mails him a list of references on file for the product in question, and he contacts the references directly.

ACU President, Hillel Segal, notes that his company does not test or rate products. Its function is to facilitate direct communication between current and potential users of the huge range of data-processing products. Says Segal, "The companies who register products with us believe in the quality of their products, and they know it's to their advantage to supply potential customers with as much useful information as possible.'



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Featuring: PolyMorphic, North Star, Imsai, Cromemco, Extensys, Speechlab products and Poly-88 Users Group software exchange. All products, 10-20% off list. We won't be undersold! A-A-A-A Discount Computer How's, 1477 Barrington, Suite 17, Los Angeles, CA 90025, 477-8478.

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Microcomputer systems for home or business; peripherals, software, books & magazines. Apple, Hewlett-Packard, North Star, Cromemco systems. IDS-440G printer w/Apple graphics, New HP-85 & HP calculators. Farnsworth Computer Center, 1891 N. Farnsworth Ave., Aurora, IL 60505, 851-3888.

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Computer Hardware/Software Specialists for home and business. Largest selection of computer books, magazines and copyrighted software in Chicago Metro area. Experienced factory-trained service department. Feature Apple and Alpha Microsystems and accessories. Data Domain of Schaumburg, 1612 E. Algonquin Road., Schaumburg, IL 60195,

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SS50-SS50C-6800-6809 specialists. Dealers for Gimix, Smoke Signal Broadcasting, SWTPC, TSC. Business Basic, Fast BASIC, payroll, editor-text processor. Custom programming AAA Chicago Computer Center, 120 Chestnut Lane, Wheeling, IL 60090, 459-0450.

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Computer systems design, programming and consultation by computer experts. Dealer for SSM, Integrand, Tarbell, Ithaca Intersystems. Verbatim, Diablo and others. Discount prices on many items. Wilcox Enterprises, 25W178-39th St., Naperville, IL 60540, 420-8601.

Dealers: Listings are \$15 per month in prepaid quarterly payments, or one yearly payment of \$150, also prepaid. Ads include 25 words describing your products and services plus your company name, address and phone. (No area codes or merchandise prices, please.) Call Marcia at 603-924-7138 or write Kilobaud MICROCOMPUTING, Ad Department, Peterborough NH 03458.

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Personal Computer Arts Festival

On Aug. 23-24, the Philadelphia area Computer Society is sponsoring PCAF'80, a festival of talks and papers, films and graphics, demonstrations and performances. Computer musicians and artists are invited to speak, exhibit or perform: send a one-half page description, and include a tape of music, by July 1. This is being held in conjunction with the Personal Computing '80 Show at the Philadelphia Civic Center.

For information, write: PCAF '80, c/o Phila. area Computer Society, Box 1954, Phila., PA 19105.

Super Scarafest '80

Super Scarafest '80, an amateur radio and computer festival, will be held Aug. 16-17, 1980, at the Ramada Inn in North Haven, CT. Sponsored by the South Central Connecticut Amateur Radio Assoc., this event will include exhibitor booths, a ham and computer flea market and

For information, write: Super Scarafest '80, PO Box 5265, Hamden, CT 06518

Eighth World Computer Congress

Australia will co-host with Japan the Eighth World Computer Congress scheduled for Oct. 6-17, 1980, and conducted by the International Federation for Information Processing (IFIP). The congress commences in Tokyo, Japan Oct. 6-9 and concludes in Melbourne, Australia Oct. 14-17. An exhibition of hardware and related services together with submission of papers and discussions will be scheduled in each location. A single registration fee will cover attendance at both locations.

For information, contact: The Eighth World Computer Congress, IFIP Congress '80, GPO Box 880G, Melbourne, Victoria, Australia 3001.

Technical Education Courses

Integrated Computer Systems has announced its line-up of technical education courses. Each course is four days and each will be held in seven cities across the country. The courses offered are: Hands-on Microprocessor Troubleshooting, Microprocessor Hands-on Workshop, Voice Input/Output for Computers, Structured Programming, Pascal Hands-on Workshop, Software/Hardware Project Management, Computer Communication Networks, Interactive Computer Graphics and Digital Image Processing.

For information contact: Integrated Computer Systems, 3304 Pico Blvd., PO Box 5339, Santa Monica, CA 90405; or Integrated Computer Systems, 300 N. Washington St., Suite 103, Alexandria, VA 22314.

Computer Sales Workshops

Datasearch is going to be holding one-day Computer Sales Workshops for front line salespeople. The session covers such topics as qualifying your prospects, making close-mouthed prospects talk, sales presentations, organizing your time and territory and handling objections. Besides the sessions in 26 cities, in-house seminars are also available.

For schedule and details, contact Cathy Koziel, Datasearch Inc., 4954 William Arnold, Memphis, TN 38117, (901) 761-9090.

Please have calendar announcements in our hands at least three months before the month of the issue in which you want the announcement to appear. Keep announcements short and to the point, and send them to the attention of the managing editor to assure their finding their way to the editorial department. Thank you.

Four Tutorials Precede Compcon Fall '80

Four pre-conference tutorials will be presented on Monday, Sept. 22, 1980, immediately preceding Compcon Fall '80, sponsored by the IEEE Computer Society. "Distributed Processing," the theme of the conference, will be the unifying thread of the tutorials. Topics to be presented are: "Local Computer Networks," "An Overview of Distributed Processing," "Communication Technology in the 80's" and "Distributed System Design." Compcon Fall '80 is September 22-25, 1980, at the Capital Hilton Hotel, Washington, DC.

For more information, write: Compcon Fall '80, PO Box 639, Silver Spring, MD 20901, or call (301) 589-3386.

Training Management Workshops

Advanced Systems, Inc. is sponsoring a series of four-day seminars in 13 U.S. and Canadian cities. Entitled "Managing the Training Function -a Workshop," the series will begin in Chicago in May, be in New York in June and be followed by workshops in Washington, D.C., Toronto, Minneapolis, Philadelphia, Seattle, Cincinnati, Boston, St. Louis, Dallas, Houston and Atlanta.

For more information write to Advanced Systems Inc., 1601 Tonne Rd., Elk Grove Village, IL 60007.

Classified advertisements are intended for use by persons desiring to buy, sell or trade used computer equipment. No commercial ads are accepted.

Two sizes of ads are available. The \$5 box allows up to 5 lines of about 35 characters per line, including spaces and punctuation. The \$10 box allows up to 10 lines. Minimize use of capital letters to save space. No special layouts allowed. Payment is required in advance with ad copy. We cannot bill or accept credit.

Advertising text and payment must reach us 60 days in advance of publication (i.e., copy for March issue, mailed in February, must be here by Jan. 1). The publisher reserves the right to refuse questionable or inapplicable advertisements. Mail copy with payment to: Classifieds, Kilobaud Microcomputing, Peterborough NH 03458. Do not include any other material with your ad as it may be delayed.

TRS-80 Exp. Int., 16K; \$350. Comprint 912GP Printer; \$489. 16K RAM; \$50. Centronics 730 printer; \$625. Compumax software; \$60. Richard Smith, 3648 Madrid Dr., San Jose, CA 95132. (408) 946-0735

Apple II, 16K; \$979. Disc II; \$414. 16K RAM; \$50. Comprint 912S; \$514. 2 sets of 4K RAM; \$15 ea. Both, \$25. Richard Smith, 3648 Madrid Dr., San Jose, CA 95132. (408) 946-0735.

For Sale: KIM-1 with TVT 6-5/8, power supply, 2K RAM, unencoded keyboard. Asking \$175 or best offer. Call (701) 968-4525, or write T. Cartwright, Box 301, Cando, ND

For Sale: SD Expandoram, S100, 16K, with 4115s, assembled, never used. \$200 or best offer. Call (701) 968-4525, or write T. Cartwright, Box 301, Cando ND 58324.

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Sell-Intertec Intertube computer terminal, latest version; cap 10 terminal extended keyboard, like new, teletype rolls, 7/8" wide, 8" diameter rolls, new, cheap by the case. Vic, 325 Wilson Ave., Westwood, NJ

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For Sale: TRS-80 Model II w/32K, 1 8" floppy disk. 15% off list price of \$3450. Asking \$2932. Like new. Call nights, David (617) 544-7347.

New bare drives, Shugart-35TK mini-floppy, MPI-40TK, Pertec-40TK, \$259 each. New Base-2 printers-includes all options, \$584 each. PO Box 1044, Orange, CA 92668. Call Paul Collin, (714) 847-3622.

For Sale: S-100 computer, quality APL mainframe, Vector Graphic Video Board, 32K dynamic, 8K static memory, 4 MHz Z-80 CPU board, PROM programming board, North Star disk, much software. D. Kirkeby, 5500 Cascade Way, #L, Buena Park, CA 90620. (714) 521-3437. Work: (714) 732-3355. Sell all or part.

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Wanted: Software and/or accessories for Video Brain 101 microcomputer. Most inter ested in Super Basic cartridge. Will pay cash. Randy Jenne, 11170-118 St., Edmonton, Alberta, Canada T5G 2W7.

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Disk Editor is a powerful machine-language utility program that will allow you total access to ANY byte of information in ANY sector in ANY track of your diskettes. It is a fast, simple, and efficient method of modifying files, whether BASIC program, system programs, or just data. All commands are readily accessible, with no need to refer to a command table.

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If you need hardcopy, use the LINE-PRINT command to send a copy of the video display to your lineprinter.

You can transfer command from Disk Editor to Radio Shack's DEBUG and back, allowing dynamic debugging of disk I/O procedures.

Disk Editor is compatible with TRS-DOS 2.1, 2.2, and 2.3, as well as with Apparat's NEWDOS. It is even capable of reading disks made by Percom's Micro-DOS.

There are two versions of Disk Editor; one is for a 35 track DOS, and the other is for a 40 track DOS. Both are included in this package.

This package requires the following minimum system:

- 1. A TRS-80 Level II with 16K RAM.
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Input shorthand: programmable keyboard up to 255 characters per key plus a pre-programmed command set.

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Instant Software

Disk Scope

 Fileloc CDisk

Password

Need to check out a disk? Perhaps you want to see how the files are stored, or you forgot your password. No problem! You've got Disk Scope.

If you know the name of the file, the Fileloc program will show you what tracks and sectors on the disk contain that file, as well as how much memory the file takes when loaded into RAM. This works for both program and data files. Fileloc then allows you to print the information, restart the program or exit to BASIC. The information obtained allows you to use the Cdiskprogram effectively.

Cdisk is a powerful little BASIC utility and test program. It will allow you to view any track and sector on your disks in ASCII. Hex and screen POKEs. It

totally disregards protection codes. It can also be used to randomly check all 350 sectors of your disk for read errors.

You don't know the whole file name if you haven't got the password, so the Password program has been included in the Disk Scope package. This machine-language utility not only gives you a password for files, but for whole disks as well.

Whether you're a novice or a pro, if you use a disk system, you need Disk Scope.

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- 2. An Expansion Interface.
- A single disk-drive.
- 4. Any compatible Disk Operating System.

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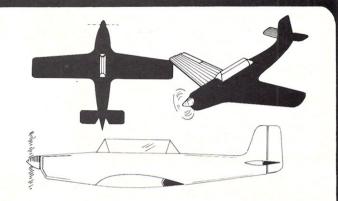
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Santa Paravia and Fiumaccio

(This program requires

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Buon giorno, signore!

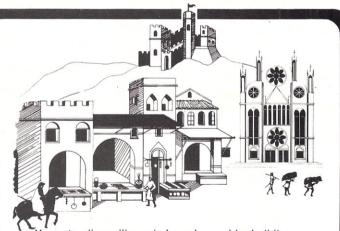
Welcome to the province of Santa Paravia. As your steward, I hope you will enjoy your reign here. I feel sure that you will

find it, shall we say, profitable.

Perhaps I should acquaint you with our little domain. It is not a wealthy area, signore, but riches and glory are possible for one who is aware of political realities. These realities include your serfs. They constantly request more food from your grain reserves, grain that could be sold instead for gold florins. And should your justice become a trifle harsh, they will flee to other lands.

Yet another concern is the weather. If it is good, so is the harvest. But the rats may eat much of our surplus, and we have had years of drought when famine threatened our popu-

Certainly, the administration of a growing city-state will require tax revenues. And where better to gather such funds than the local marketplaces and mills? You may find it necessary to increase custom duties as well as tax the incomes of the merchants and nobles. Whatever you do, there will be far-reaching consequences . . . and possibly an elevation of your noble title.



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To measure your yearly progress, the official mapmaker will draw you a mappa. From it you can see how much land you hold, how much of it is under the plow, and how adequate your defenses are. We are unique in that here, the map IS the

I trust that I have been of help, signore. I look forward to the day when I may address you as His Royal Highness, King of Santa Paravia. Buon fortuna, or, as you say, "Good luck Order No. 0174A \$9.95.

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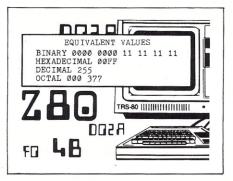
BEGINNER'S RUSSIAN The three programs in this package will give you onscreen displays of the Cyrillic letters, detailed instructions on their proper pronunciation, and exercises that will have you recognizing and speaking simple Russian words.

This package is excellent for students, businessmen, scientists, and anyone who is interested in learning the Russian language. For the TRS-80 Level II 16K. Order No. 0136R \$9.95.



EVERYDAY RUSSIAN This program will acquaint you with the words for various foods, places to eat, signs, and the names of stores - exactly what a traveller needs

You can practice typing in Russian. The program will allow you to type in letters, or words, using the complete Cyrillic alphabet. Practice writing words such as hotel names, tourist attractions, and street addresses. All you need is a TRS-80 Level II 16K. Order No. 0137R \$9.95.



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Chessmate allows you to set up the



board and play end games or special prob-

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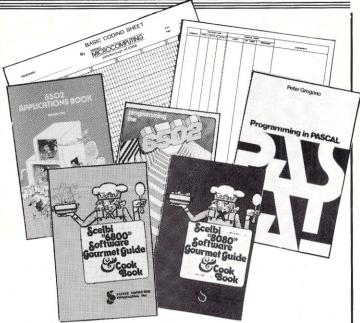
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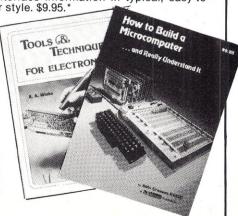
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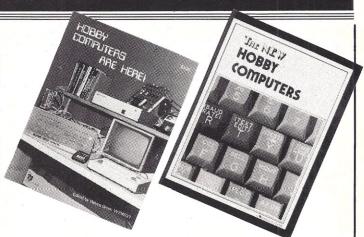


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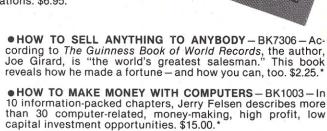
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Long a standard for software development and interchange for all the "other" 8080/Z80 computers on the market, CP/M will now provide the same environment for the TRS-80. CP/M is a file-oriented disk operating system that provides a common set of utilities for program development and operation. There are six built in commands plus utilities called in from disk. CP/M will run on a TRS-80 with as little as 16k of memory and one disk drive. Comes complete with six manuals, CP/M is a registered trade mark of Digital Research.

VIDEO BOARD

I/O controlled video interface board. With a TV 16, all upper case and is selectable for white on-black or black-on-white.

At last, CP/M is available for the TRS-80

TRS-80 Level II 16k-w/disk \$149.95

ATARI® HOME VIDEO SYSTEM

The nation's best selling home entertainment center is here! Currently supports a library of 25 video game cartridges with over 1300 variations and options. This system comes with interchangeable joystick and paddle controllers, realistic sound effects, produces bright & crisp colors on your TV screen and special circuits to protect your home TV. Also includes ATARI's "Combat" game with 108 variations and options.



Starship Black Jack Space War Surround Slot Machine Slot Machine
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Slot Racer
Video Olympics
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Canyon Bomber
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CAT NO. 2375 2206 2207 2208 DESCRIPTION ATARI Home Video System Driving Controller-Pair Paddle Controller-Pair Joystick Controller-Pair

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Leedex VID€O 100 12" MONITOR

Compatible with TRS-80 (no interface required)
 Compatible with many home computers!

MICROPOUS® DISK DRIVES Imagine a $5\,\%$ " floppy disk system with all the storage capacity of an 8 " floppy system, and more! Micropolis can give you more storage because they pack more data onto every disk. Ordinary 5¼ "floppies provide just 35 tracks per drive and store 70 to 130 K bytes of data. Instead, Micropolis uses 77 tracks-each with 16 sectors of 156 bytes to yield an incredible storage capacity of 315k bytes per drive.

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Micropolis reliability is engineered into each step of manufacturing. For example, most 5¼ " floppy disks cut costs by using a plastic cam or cam follower to position the read/write head. Micropolis chose to

use the strength and durability of an all steel cam and cam follower. Sure, it costs more, but it gives you more accurate tracking over a significantly greater lifespan which adds up to a lower cost per byte with use. Software from Micropolis includes a comprehensive DOS,

(disk operating system), and disk Extended Basic designed for 8080/Z80 microcomputer systems. The DOS is complete with an as-sembler, editor, file management functions and disk utilities. Micro-

BOBOV 280 microcomputer systems. The DUS is complete with an assembler, editor, file management functions and disk utilities. Micropolis BASIC is a complete, powerful programming tool for developing, testing, executing and maintaining basic programs. The model 1043 M0D II is a single floppy disk with 315k bytes storage and includes the S-100 disk Controller board. If you need more storage, or simply want to save even more money, then order the model 1053 M0D II dual disk system with 630k bytes storage capacity and S-100 Controller board. Micropolis DOS and disk extended RASIC are standard with both units.

(Programma Improved Editor)

Don't be mislead by the low price of this outstanding wordprocessing package. PlE 2.0 is a powerful text editor and print format processor that has all the belis and whistles expected of wordprocessing software costing three times as much. Some features include:

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2) Complete Cursor mobility
3) String search forward and backward
4) Single, conditional or global search and replace
5) Mayer and/or copy blocks of text

4) Single, conditional or global search and replace
5) Move and/or copy blocks of text
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Research conducted by IBM Corp. revealed that the time required to create, edit and complete a one page document was decreased by as much as 60% when comparing the performance of a Wordprocessing system to an ordinary typewriter. Finding ways to remain competitive these days is a challenge for the business executive. Todays office can substantially improve their daily productivity level with PIE 2.0 Wordprocessing software and an Apple II computer with 32k RAM memory.

memory.

As a businessman you want every dollar you spend to count, so wordprocessing makes sense, and PIE 2.0 Wordprocessing software gives you more for your hard earned dollar, PIE 2.0 Wordprocessing software comes complete with program diskette and detailed documentation in a handsome, simulated leather binder.

\$79.95

Weight 9 lbs 18 lbs

\$1145.00 \$1895.00

BASIC are standard with both units.

TH€ PI€ 2.0

Cat No.

Description
Model 1043 mod II single drive
Model 1053 mod II dual drive

Now from LEEDEX . . . One of the most popular low cost, yet high resolution (650 line) monitors currently available. These units compare favorably with monitors costing twice as much. Because of the fact that standard composite video input is utilized no RF modulator is needed. An extremely sharp and stable picture is achieved. The video



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Delivery January '80

1802 16K Dynamic RAM Kit \$149.00 Expandable to 32K. Hidden refresh w/clocks up to 4 MHz w/no wait states Addl. 16K RAM \$63

Quest Super Basic

Quest, the leader in inexpensive 1802 systems announces another first. Quest is the first company worldwide to ship a full size Basic for 1802 systems. A complete function Super Basic by Ron Cenker including floating point capability with scientific notation (number range ± .17E³⁸), 32 bit integer ±2 billion; Multi dim arrays; String arrays; String manipulation; Cassette I/O, Save and load, Basic, Data and machine language programs; and over 75 Statements, Functions and Operators.

Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user programs. Cassette version in stock now. ROM versions coming soon with exchange privilege

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Coming Soon: Assembler, Editor, Disassembler, DA/AD, Super Sound/Music, EPROM programmer, Stringy Floppy System.



RCA Cosmac Super Elf Computer \$106.95

compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable bene-fits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many big things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily expanded with additional memory, Full Basic, ASCII Keyboards, video character generation, etc.

Before you buy another small computer, see if it includes the following features: ROM monitor: State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker: Fully socketed for all IC's: Real cost of in warranty repairs; Full documentation.

The Super Elf includes a ROM monitor for pro-gram loading, editing and execution with SINGLE STEP for program debugging which is not in-cluded in others at the same price. With SINGLE STEP you can see the microprocessor chip opera-ting with the unique Quest address and data bus displays **before**, **during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 video graphics chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a speaker system included for writing your own music or using many music programs already vritten. The speaker amplifier may also be used to drive relays for control purposes

Super Expansion Board with Cassette Interface \$89.95

This is truly an astounding value! This board has been designed to allow you to decide how you been designed to allow you to decide how you want it optioned. The Super Expansion Board comes with 4K of low power RAM fully addressable anywhere in 64K with built-in memory protect and a cassette interface. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the Super Elf. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is fully socketed. EPROM can be used for the monitor and Tiny Basic or other purposes.

A IK Super ROM Monitor \$19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/ editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with

A 24 key HEX keyboard includes 16 HEX keys plus load, reset, run, wait, input, memory protect, monitor select and single step. Large, on board displays provide output and optional high and low address. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for all IC's are in-cluded in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info, including a series of lessons to help get you started and a music program and Many schools and graphics target game. universities are using the Super Elf as a course of study. OEM's use it for training and R&D.

Remember, other computers only offer Super Elf before you buy. Super Elf Kit \$106.95, High address option \$8.95, Low address option \$9.95. Custom Cabinet with drilled and labelled plexiglass front panel \$24.95. Expansion Cabinet with room for 4 S-100 boards \$41.00. NiCad Battery Memory Saver Kit \$6.95. All kits and options also completely assembled and tested Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for \$12.00 per year. Issues 1-12 bound \$16.50.

Tiny Basic Cassette \$10.00, on ROM \$38.00, original Elf kit board \$14.95. 1802 software; Moews Video Graphics \$3.50. Games and Music \$3.00, Chip 8 Interpreter \$5.50.

subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the Super Expansion Board and Super Monitor the monitor is up and running at the push of a button.

Other on board ontions include Parallel Input and Output Ports with full handshake. They allow easy connection of an ASCII keyboard to the input port. RS 232 and 20 ma Current Loop for teletype or other device are on board and if you need more memory there are two **\$-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. Parallel I/O Ports \$9.85, RS 232 \$4.50, TTY 20 ma I/F \$1.95, S-100 \$4.50. A 50 pin connector set with ribbon cable is available at \$15.25 for easy connection between the Super Elf and the Super Expansion Board.

Power Supply Kit for the complete system (see Multi-volt Power Supply below).

Same day shipment. First line parts only Factory tested. Guaranteed money back Quality IC's and other components at factory prices

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704/2708 EPROM PROGRAMMER

- 3 separate Display Registers: 8 LED's for Hex Key entries, 10 LED's (2º-2º) for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the EPROM.
- Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board.
- · Rapid checking verification of programmed data changes.
- · User may move data from a master to RAM's or write into RAM's with keyboard entries.
- Allows manual stepping manipulation (up and down) at any address location.
- Stand-alone EPROM Programmer consisting of:
- A 19-key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 6W.
- Compact desk-top enclosure: Color-coordinated designer's case with light tan panels and end pieces in molded mocha brown. Size: 3%"H x 11"W x 8%"D. Weight: 5 lbs.

The JE608 EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program, for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board with 25 IC's and including power supplies of: -5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED/ Test Socket Panel board are separate assemblies within the system.

JE608

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- TO COMPARE EPROM(S) FOR CONTENT **DIFFERENCES**
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JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and —12V @ 10mA for operation. Features: 60 keys generate the full 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector.

JE610 ASCII Encoded Keyboard Kit only . . \$79.95

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit

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SPECIAL: JE610/DTE-AK PURCHASED TOGETHER

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FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD



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JE600 Hexadecimal Board Kit only \$59.95

Desk-Top Enclosure for JE600 Hexadecimal Keyboard Kit

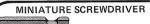
Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 8¼"W x 8¾"D.

SPECIAL: JE600/DTE-HK PURCHASED TOGETHER

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Input Impedance: 300,000 Ohms, Thresholds: "Lo" 30%Vcc — "Hi" 70%Vcc Maximum Speed: 300 nsec., 1.5MHz Input Protection: ±50VDC continuous 117VAC

Power: 30mA @5V - 40mA @ 15V - 25V max. reverse voltage protected; 36" cable with color coded clips included.

Operating Temp.: 0-50°C Dimensions: $5.8L \times 1.0W \times 0.7D$ in. $(147 \times 25 \times 18mm)$ Weight: 30 oz. (85 gm)

LPK-1..... \$21.95/Kit



Proto Clips

14-PIN CLIP	PC-14			\$ 4.50
16-PIN CLIP	PC-16			\$ 4.75
24-PIN CLIP	PC-24			\$10.00
40-PIN CLIP	PC-40			\$16.00

Proto Boards



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Jumbo 6-Digit Clock Kit

- * Four .630"ht. and two .300"ht.
- Four .50"ht, and two .300"ht. common anode displays Uses MM5314 clock chip Switches for hours, minutes and hold functions Hours easily viewable to 30 feet Simulated walnut case 115VAC operation 12 or 24 hour operation

- 12 or 24 nour operation
 Includes all components, case and wall transformer
 Size: 6¾ x 3¾ x 1¾

JE747 \$29.95



- Bright .300 ht. comm. cathode display
 Uses MM5314 clock chip
 Switches for hours, minutes and hold modes
 Hrs. easily viewable to 20 ft.
 Simulated walnut case

Simulated walnut case
115 VAC operation
12 or 24 hr. operation
Incl. all components, case wall transformer
Size: 6%" x 3-1/8" x 1%" **JE701** 6-Digit Clock Kit \$19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid — 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes composers. nents, hardware and instructions. Size: 3½" x 5" x 2"H

JE200......\$14.95



ADAPTER BOARD —Adapts to JE200— $\pm 5V$, $\pm 9V$ and $\pm 12V$

DC/DC converter with +5V input. Toriodal hispeed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205\$12.95

MICROPROCESSOR COMPONENTS

	8080A/8080A SUPPORT DEVICES	-		-MICROPRI	OCESSOR MANUALS	-
8080A	CPU	\$ 7.95	M-Z80	User Manu	al	\$7.50
8212	8-Bit Input/Output	3.25	M-CDP1802	User Manu		7.50
8214	Priority Interrupt Control	5.95	M-2650	User Manu		5.00
8216	Bi-Directional Bus Driver	3.49	IN 2000	Occi mano		
8224	Clock Generator/Driver	3.95			ROM'S	
8226	Bus Driver	3.49	2513(2140)	Character (Generator(upper case)	\$9.95
8228	System Controller/Bus Driver	4.95	2513(3021)		Generator(lower case)	9.95
8238	System Controller	5.95	2516(3021)	Character		10.9
8251	Prog. Comm. 1/0 (USART)	7.95	MM5230N		tead Only Memory	1.95
8253	Prog. Interval Timer	14.95	MINDSZOW	2040-DIL P	lead Only Memory	1.50
8255	Prog. Periph. 1/0 (PPI)	9.95			- RAM'S	
8257	Prog. DMA Control	19.95	4404	256X1	Static	\$1.49
8259	Prog. Interrupt Control	19.95	1101			.91.41
	-6800/6800 SUPPORT DEVICES		1103	1024X1	Dynamic	3.9
MC6800	MPU	\$14.95	2101(8101)	256X4	Static	1.7
MC6802CP	MPU with Clock and Ram	24.95	2102	1024X1	Static	
MC6810API	128X8 Static Ram	5.95	21L02	1024X1	Static	1.9
MC6821	Periph. Inter. Adapt (MC6820)	7.49	2111(8111)	256X4	Static	
MC6828	Priority Interrupt Controller	12.95	2112	256X4	Static MOS	4.9 7.9
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95	2114	1024X4	Static 450ns	
MC6850	Asynchronous Comm. Adapter	7.95	2114L	1024X4	Static 450ns low power	10.9
MC6852	Synchronous Serial Data Adapt.	9.95	2114-3	1024X4	Static 300ns	10.9
MC6860	0-600 bps Digital MODEM	12.95	2114L-3	1024X4	Static 300ns low power	11.9
MC6862	2400 bps Modulator	14.95	5101	256X4	Static	7.9
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25	5280/2107	4096X1	Dynamic	4.9
	OPROCESSOR CHIPS—MISCELLANEO		7489	16X4	Static	1.7
			74S200	256X1	Static Tristate	4.9
Z80(780C)	CPU	\$13.95	93421	256X1	Static	2.9
Z80A(780-1)		15.95	UPD414	4K	Dynamic 16 pin	4.9
CDP1802	CPU	19.95	(MK4027)			
2650	MPU	19.95	UPD416	16K	Dynamic 16 pin 250ns	7.9
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P8085	CPU	19.95	45NL			
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MM500H	Dual 25 Bit Dynamic	\$.50	MM5262	2KX1	Dynamic	4/1.0
MM503H	Dual 50 Bit Dynamic	.50	0.000000000	CONT.	PROM'S	
MM504H	Dual 16 Bit Static	.50				
MM506H	Dual 100 Bit Static	.50	1702A	2048	FAMOS	\$5.9
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MM5016H	500/512 Bit Dynamic	.89	TMS2516	16K*	EPROM	24.9
2504T	1024 Dynamic	3.95	(2716)	*Requires	single +5V power supply	
2518	Hex 32 Bit Static	4.95	TMS2532	4KX8	EPROM	89.9
2522	Dual 132 Bit Static	2.95	2708	8K	EPROM	10.5
2524	512 Static	.99	2716 T.I	16K**	EPROM	29.5
2525	1024 Dynamic	2.95	**P	Requires 3 v	oltages, -5V, +5V, +12V	
2527	Dual 256 Bit Static	2.95	5203	2048	FAMOS	14.9
2528	Dual 250 Static	4.00	6301-1(7611) 1024	Tristate Bipolar	3.4
2529	Dual 240 Bit Static	4.00	6330-1(7602	256	Open C Bipolar	2.9
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7-10070	The Inspired The (Thotate)	2.10	74186	512	TTL Open Collector	9.9
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A-Y-5-1013	30K BAUD	5.95	74S287	1024	Static	2.9
V-1-0-1019	OUR DROD	0.30				_

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Provides 3 basic waveforms: sine, triangle and square wave. Freq. range from 1 Hz to 100 K. Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V splif supply. Includes chip, P.C. Board, components & instructions.

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DIGITAL THERMOMETER KIT



*Dual sensors—switching control for in-door/outdoor or dual monitoring Continuous ED .8 ht. display Continuous ED .8 ht. display Control of the control of the control *Accuracy: ±1° nominal Set for Fahrenheit or Celsius reading *Sim. walnut case - AC well adapter incl. *Size: 3.1/4" Nt.6.5/8" WW.1-3/8" O

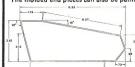
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DESIGNERS' SERIES Blank Desk-Top Electronic Enclosures



- High strength epoxy molded end pieces in mocha brown finish.
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- Top / bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency. Rigid construction provides unlimited applications.

The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to "A" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



	Enclosure Model No.	Panel Width	PRICE
1	DTE-8	8.00"	\$29.95
2.04	DTE-11	10.65"	\$32.95
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The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly another modern and terminal for telephone "famming" and communications. I addition, it is fixed or critical adjustments and is built with non-precision, readily availabil

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Data Transmission MethodFrequency-Shift Keying, full-duplex (half-duplex selectable) . "requestly-simit Keynig, intri-outpiet (inter-outpiet security) seems of the security of the Maximum Data Rate...........
Data Format Receive Frequency Tolerance. Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.

Digital Data Interface. ELR 85-2320 or 20 mA current loop (receiver is optiosiolated and non-polar).

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Physical ... All components mount on a single 5" by 9"
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Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align. **TRS-80** 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:

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(it comes complete with:
8 each UPD416-1 (16K Dynamic Rams) 250NS
Documentation for conversion

TRS-16K\$59.95



		JW-1-R	Red	14.95
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JW-1-W

Part No.	Color	Price
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Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1½" jaws, 1½" travel. Can be permanently installed.

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IDEAL FOR ALL VIDEO GAMES OR REMOTE CONTROL PROJECTS

SMALL CASE SIZE: 1-1/2"H x 2-3/8"W x 4-5/16"L 2 MINIATURE POTENTIOMETERS-40K OHM EACH SPST PUSH BUTTON CONTROL

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32K S-100 EPROM CARD



USES 2716's

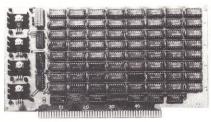
Blank PC Board - \$34

ASSEMBLED & TESTED ADD \$30

SPECIAL: 2716 EPROM's (450 NS) Are \$19.95 EA. With Above Kit

- 1. Uses +5V only 2716 (2Kx8) EPROM's
- Allows up to 32K of software on line!
- 3. IEEE S-100 Compatible.
- Addressable as two independent 16K blocks.
- 5. Cromemco extended or Northstar bank select.
- 6. On board wait state circuitry if needed. 12. Easy and quick to assemble
- 7. Any or all EPROM locations can be disabled.
- 8. Double sided PC board, solder-masked, silk-screened.
- q Gold plated contact fingers.
- 10. Unselected EPROM's automatically powered down for low power.
- 11. Fully buffered and bypassed.

8K LOW POWER RAM KIT-S 100 BUSS



21L02 (450 NS RAMS!)

KIT

ASSEMBLED & FULLY **BURNED IN ADD \$35**

Thousands of computer systems rely on this rugged, work horse, RAM board. Designed for error-free, NO HASSLE, systems use

ADD \$10 FOR 4 MHZ

SALE!

FOR

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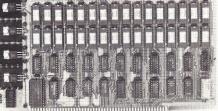
LOW POWER - 300NS 2114 RAM SALE! 8 FOR \$44

4MHZ 4K STATIC RAM'S. MAJOR BRAND, NEW PARTS. These are the most sought after 2114's, LOW POWER and 300NS FAST. 8 FOR \$44

16K STATIC RAM KIT-S 100 BUSS



ADD \$10



KIT FEATURES:

- Addressable as four separate 4K Blocks
- memco Standard!). Allows up to 512K on line!
 3. Uses 2114 (450NS) 4K Static Rams.
- 3. Uses 2114 (450NS) 4R Static Hains.
 4. ON BOARD SELECTABLE WAIT STATES.
 5. Double sided PC Board, with solder mask and SUPPORT IC'S & CAPS-\$19.95
- silk screened layout. Gold plated contact fingers.

 6. All address and data lines fully buffered. Kit includes ALL parts and sockets.
- PHANTOM is jumpered to PIN 67.
 LOW POWER: under 1.5 amps TYPICAL from
- the +8 Volt Buss
- 10. Blank PC Board can be populated as any multiple of 4K.

 ON BOARD BANK SELECT circuitry. (Cro ON BOARD BANK SELECT circuitry. (Cro BLANK PC BOARD W/DATA-\$33 LOW PROFILE SOCKET SET-\$12

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COMPLETE KIT! **\$84**95 (WITH DATA MANUAL)

BLANK PC BOARD W/DATA

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16K STATIC RAM SS-50 BUSS

PRICE CUT!

FULLY STATIC!

FOR 2MHZ **ADD \$10**

> FOR SWTPC 6800 BUSS!

ASSEMBLED AND TESTED - \$35

KIT FEATURES:

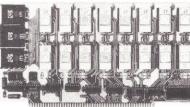
- Addressable on 16K Boundaries Uses 2114 Static Ram

- Fully Bypassed
 Double sided PC Board. Solder mask and silk screened layout.
- All Parts and Sockets included

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EPROM CARD-S 100 BUSS



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USES 2708's!

Thousands of personal and business systems around the world use this board with complete satisfaction. Puts 16K of software on line at ALL TIMES! Kit features a top quality soldermasked and silk-screened PC board and first run parts and sockets. Any number of EPROM locations may be disabled to avoid any memory conflicts. Fully buffered and has WAIT STATE capabilities.

ASSEMBLED AND FULLY TESTED — ADD \$30

OUR 450 NS 2708'S ARE \$8.95 EA. WITH PURCHASE OF KIT

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THE DUAL PROCESSOR S-100 CPU BOARD: INNOVATIVE, POWERFUL, FLEXIBLE

The Dual Processor Board gives true 16 bit power with an 8 bit bus, is downward compatible with the vast library of 8080 software, is upward compatible with hardware and software not yet developed, accesses up to 16 megabytes of memory, meets all IEEE S-100 specifications, runs 8085 and 8086 code in existing S-100 mainframes as well as Microsoft 8086 BASIC and Sorcim PASCAL/M™, runs at 5 MHz for speed as well as power, and is built to the same stringent standards that have established our leadership in S-100 system

What accounts for this unprecedented level of performance? The Dual Processor Board includes two CPUs: the 8088, an 8 bit bus version of the 8086 16 bit CPU, and the 8085 (an advanced 8 bit CPU that can run existing software such as CP/M).

Amazingly enough, all this power is still cost-effective. Introductory prices are \$385 unkit, \$495 assembled, and \$595 CSC. The Dual Processor Board is here . . . and CPU boards will never be the same again.

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This is a single processor version of the Dual Processor Board for those who do not yet need 16 bit capability. Includes all standard 8085 features. Introductory prices: \$235 unkit, \$325 assm, \$425 CSC.

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Includes all standard Z-80 board features, conforms to all IEEE timing specifications, and features power on jump/clear, on-board fully maskable interrupts for interrupt-driven systems, selectable automatic wait state insertion, provision for adding up to 8K of EROM, 4 MHz operation, and on-board IEEE compatible 16/24 bit extended addressing.

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THE "RAM" **SERIES OF** STATIC MEMORY

NOTE: Most CompuPro boards are available in unkit form (sockets, bypass caps pre-soldered in place), assembled, or qualified under the Certified System Component (CSC) high-reliability program (200 hour burn-in, more). CSC memories run at 8 MHz and draw even less power than standard models

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Recommended for commercial, industrial, and scientific applications. 4/5 MHz standard operation, no dynamic timing problems, meets all IEEE specifications, low power/high speed chips used throughout, extensive bypassing, careful thermal design.

S-100 STANDARD MEMORY

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8K RAM	IIA	 \$169	\$189	\$239
16K RAM	X-16	 \$329	\$379	\$479
24K RAM	XX-24	 \$449	\$499	\$599
32K RAM	X-32	 \$599	\$689	\$789

S-100 EXTENDED ADDRESSING MEMORY

(16/24 address lines	addressable on 4K bou	ndaries)
16K RAM XIV	\$299	\$349 \$429

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(Cromemco etc. compatible; addressable on 4K bo	undaries)
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24K RAM XIIIA-24\$479 \$539	\$649
32K RAM XIIIA-32\$649 \$729	\$849

SBC/BLC MEMORY

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Includes 8K of IEEE-compatible static RAM; full duplex bidirectional parallel I/O port for keyboard, joystick, etc. interface; and 6847-based graphics generator that can display all 64 ASCII characters. 10 modes of operation, from alphanumeric/semi-graphics in 8 colors to ultra-dense 256 × 192 full graphics. 75 Ohm RS-170 line output and video output for use with FCC approved modulators. Introductory prices: \$339 unkit, \$399 assm, \$449 CSC. Don't settle for black and white graphics or stripped-down color boards;

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PASCAL — easy to learn, easy to apply — can give a microcomputer with CP/M more power than many minis. We supply a totally standard Wirth PASCAL/M™ 8" diskette by Sorcim, with manual and Wirth's definitive book on PASCAL, for \$150 with the purchase of any memory board. Specify Z-80 or 8080/8085 version. PASCAL/M™ available separately for \$175.

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Limited quantity; 32K static RAM in kit (not unkit) form. With all parts, documentation, mounting bracket, etc. Includes solder masked, fully legended board for easy assembly. 32K kit: \$549

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Godbout Computer Enclosure	
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12 Slot Hi-Performance Motherboard	\$129 unkit, \$169 assm
20 Slot Hi-Performance Motherboard	\$174 unkit, \$214 assm
Active Terminator Board	\$34.50 kit
2708 EPROM Board (less EPROMs)	\$85 unkit
Memory Manager Board	\$59 unkit, \$85 assm, \$100 CSC
2S "Interfacer I" I/O Board	\$199 unkit, \$249 assm, \$324 CSC
3P Plus S "Interfacer II" I/O Board	\$199 unkit, \$249 assm, \$324 CSC
Mullen Extender Board	\$59 kit
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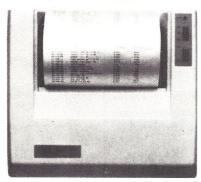
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Printing Characteristics: 225 characters/ second (170 lines/minute) throughput ● 9 horizontal x 12 vertical matrix ● 96 ASCII character set with upper and true lower case

80 characters/line ● 5.8 lines/inch **Buffer Memory:** standard 256 bytes; ● optional; 2,048 bytes (buffer memory optional; 2,048 bytes (buffer memory optional); 2,048 bytes (buffer mem Paper Requirements: electrosensitive type (aluminum coated) ● 8-1/2 inch width ● 3.7 inch max. (300 ft.) roll diameter.

Model 912-S Interfacing: serial interface RS232 and 20 mA current loop ● BAUD rates 110, 150, 300, 600, 1200, 2400 and 4800 are strap selectable.

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Converts video to AM modulated RF Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple • Power required is 12 volts AC C.T., or +5
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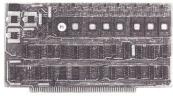
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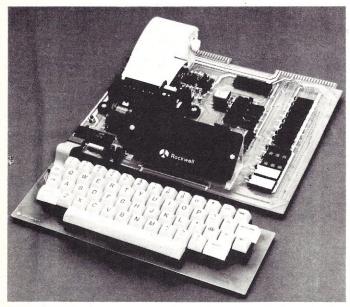
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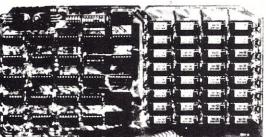


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When you purchase any S.D. SYSTEMS Computer Board, either kit or A&T from PRIORITY 1 ELECTRONICS you will receive a COUPON FOR A \$25.00 CASH REBATE Direct from the Manufacturer SD SYSTEMS. Combine the Rebate with our already low prices, and you can hardly afford to pass up this special offer.

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SD EXPANDORAM The Ultimate S-100 Memory



EXPANDO 64 KIT (4116):

Sale Price \$189.00 32K 48K 64K

Bank Selectable Phantom Power 8VDC, ± 16VDC, 5 Watts Lowest Cost Per Bit Uses Popular 4116 RAMS

The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have

a memory system that will grow with your needs. This is a dynamic memory with the invisable on-board refresh, and IT WORKS! Interfaces with Altair, IMSAI, SOL-8, Cromenco,

Board is doubled solder masked and has silk-screen parts layout. \$189.00
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• Extensive documentation clearly written
• Complete Kit includes all Sockets for 64K
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• Memory access time: 375ns, Cycle time: 500ns.
• No wait states required.
• 16K boundries and Protection via Dip Switches

16K boundries and Protection via Dip Switches Designed to work with Z-80, 8080, 8050 CPU's

VERSAFLOPPY II

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- S-100 Bus IEEE Standard Compatible IBM-3740 Compatible Soft Sectored Format for Single
- Sectored Turnes Density Drives Operates with both Standard (8") and Mini (5") Drives Simultaneously Provides Control for Double
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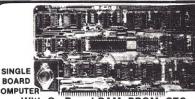
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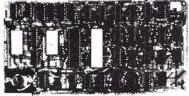


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280 Central Processing Unit
1024 Bytes of Random Access Memory
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SD SYSTEMS' PROM-100 is a versatile PROM programming board offering complete EPROM programming capability. The board operates on the industry standard \$5.100 Bus. Support software verifies the erasure of EPROM and verifies the loaded program. SD SYSTEMS' PROM-100 offers a support-software listing with its operations manual.

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Programs the Following EPROM s: 2708, Intel 2758, 2716, 2732 and Texas Instruments 2516
Dip Switch Selection of EPROM type
25 VDC Programming Pulse Generated On Board
Maximum Programming fime: 16,384 Bits in 100 Seconds
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RIBBON SYSTEM: Continuous ribbon 916" (14mm) wide 20 yards (18.3 meters) long. Mobius Loop allows printing on upper and lower portion on alternate passes OPERATOR CONTROLS: Power onioff Reset Switch -allows disabling of printer without dropping AC.

dropping AC
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dicates that data was received
PHYSICAL DIMENSIONS: Weight: less than 10 lbs/5 kg -Width: 145 inches/37 cm
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CEN-730-1 (Parallel Int.)

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TRS-80/APPLE MEMORY EXPANSION KITS EZ:00. 8 for \$50.00 ADD \$3.00 FOR PROGRAMMING JUMPERS FOR TRS-80 KEYBOARD 4116's 100 pcs & UP \$5.20 each 1000 pcs & UP \$4.45 each

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OUR CORNER state variable circuitry that delivers a nearTHE MARKET PRICE by harmonic free, phase coherent sine wave
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it prevents chatter when the received

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EXCLUSIVE ACOUSTIC CHAMBERS.

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Utilizing the experience gained from building high quality couplers for over twelve years. Livermore has designed a coupler superior to any in its class for cost efficiency in industrial. commercial business or home situations. You can see why we call it the STAR!

232 specifications. Teletype Interface. 20 milliampere current

Optional Interfaces, IEEE 488: TTL: TTY 43.

*International (CCITT) frequencies

coupler superior to any in its class for cost efficiency in industrial, commercial, available, business or home situations You can see why we call it the STAR! SPECIFICATIONS Data Rate, 0 to 30 baud of 13. CCITT Transmit Frequencies. To Griginate – 100. HZSpace, 1270 HZ/Mark, Answer 2025 HZ/Mark, Answer 2015 HZ/Space, 1270 HZ/Mark, Answer 2017 HZ/Space, 1270 HZ/Mark, Answer 1010 HZ/Space, 1270 HZ/Space, 1270 HZ/Mark, Answer 1010 HZ/Space, 1270 HZ/Space, 1270

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MHZ EXPANDORAM II KIT The S-100 Memory Board for the 80's

SD SYSTEMS' ExpandoRAM II is a state-of-the-art • S-100 Bus Compatible dynamic RAM board with capacities from 16K bytes • Up to 4Mhz Operation (4116) to 256K bytes (4164). It operates on the industry • Expandable Memory from 16K to 256K S-100 Bus. The ExpandoRAM II's design allows eight

• DIP Switch Selectable Boundaries

boards to operate from the same S-100 Bus. Page

• Uses 16K (4115) or 64K (4164) Memory Devices mode operation provides the system with the capabil-

Page Mode Operation Allows up to 8 Memory ity of servicing multiple users without RAM interference. Invisible refresh and synchronization with • Operates with Z80 CPU's wait states provide greater reliability, and processing

Phantom Output Disable

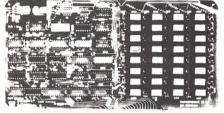
Invisible Refresh (Synchronized with

The ExpandoRAM II is compatible with some S-100 CPU's based on the Z80 microprocessor. When other SD SYSTEMS 200 series boards are combined with the ExpandoRAM II, they create a microcomputer with excentional canabilities and features

Wait States)

DON'T FORGET YOUR REBATE





SDS - EXPANDOPRAM II KIT (4116)

16K . . . \$280.00 48K.. \$399.00

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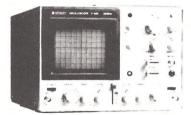
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Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an 8155 ROM-I/O—all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 ex-

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(Level "A" makes a perfect OEM controller for industrial applications and is available in a special Hex Version which can be programmed using the Netronics Hex Keypad/

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PC Board: glass epoxy, plated through holes with solder mask • I/O: provisions for 25-pin (DB25) connector for terminal serial I/O, which can also sup-port a paper tape reader ...provision for 24-pin DIP socket for hex keyboard/dis-play cassette tape recorder in

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play...cassette tape recorder in-routput...cassette tape control LED output indicator on SOD troller use.
put...cassette tape recorder
output...speaker output... output...speaker output... LED output indicator on SOD (serial output) line...printer interface (less drivers)...total of four 8-bit plus one 6-bit 1/O ports • Crystal Frequency: 6.144 MHz • Control Switches: reset and user (RST 7.5) interrupt...additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • Counter/Timer: programmable, 14-bit binary • System RAM: 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems...RAM expandable to 64k via S-100 bus or 4K on motherboard.

AK on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000 leaving 00000 free for user RAM/ROM. Features include tape load with labeling ... tape dump with labeling ... examine/change contents of memory ... insert data... warm start... examine and change all registers... single step with register display at each break point, a debugging/training feature... go to execution address... move blocks of memory from one location to another... fill blocks of memory with a constant... display blocks of memory control (1-255 characters/line)... channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

ommunicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling.

tape dump with labeling...examine/change contents of mem-ory...insert data...warm start...examine and change all



registers...single step with register display at each break point...go to execution address. Level "A" in the Hex Version makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.



Specifications

Calculator type keypad with 24
system defined and 16 user
defined keys. 6 digit calculator
type display which displays full
address plus data as well as register and status information.

Hex Keypad/Display Specifications

Level "B" Specifications

Level "B" Specifications
Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k EPROM expansion selectable in 4k blocks... address decoding for onboard 8k EPROM expansion selectable in 8k blocks... address and data bus drivers for onboard expansion... wait state generator (jumper selectable, to allow the use of slower memories...two separate 5 volt regulators.

Explorer/85 with Level card cage.

Level "C" Specifications
Level "C" expands Explorer's
motherboard with a card cage,
allowing you to plug up to six
S-100 cards directly into the
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cards are neatly contained inside
Explorer's deluxe steel cabinet.

Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the mother-board. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 00000 to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

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Experimenter's Pak (SAVE \$12.50)—Buy Level "A" and Hex Keypad/Display for \$199.90 and get FREE Intel 8085 user's manual plus FREE postage & handling!

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plus FREE postage & handling!
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Netronics R&D Ltd.

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plus \$2 p&h. Level "E" (EPROM/ROM) Kit,

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The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard.

and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

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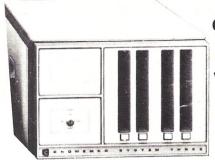
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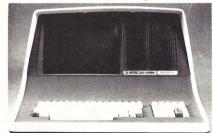
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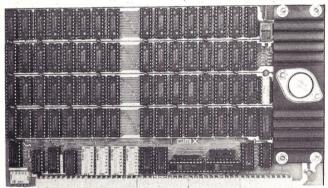
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The Promise. "Thou shalt not wait, worry or fret." You'll get immediate post-paid delivery from in-stock inventory. You'll get a full 12 month warranty. That's about four times the warranty others offer. And for installation, you'll get UHF's "goof-proof" instructions. All you'll need is a screwdriver and about 10 minutes.

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